THE Chemical Age

VOL. LXXIV 14 JANUARY 1956 No. 1905

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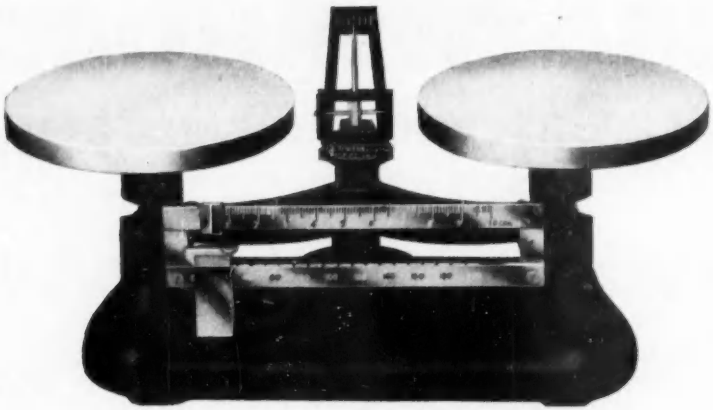

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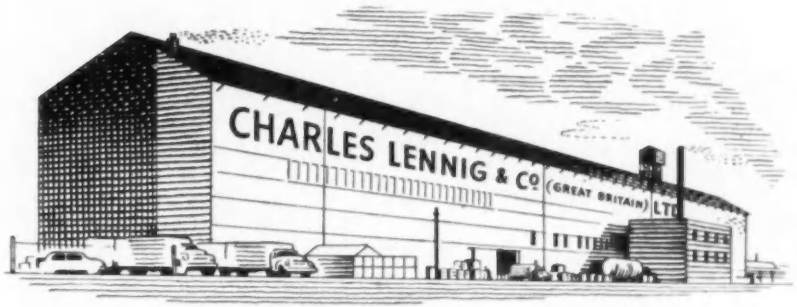

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ROHM & HAAS "AMBERLITE" ion exchange resins are now being manufactured at the new Jarrow-on-Tyne Plant of the Charles Lennig & Company (Great Britain) Ltd. The AMBERLITE resins currently available are AMBERLITE IR-120 and AMBERLITE IRA-400.

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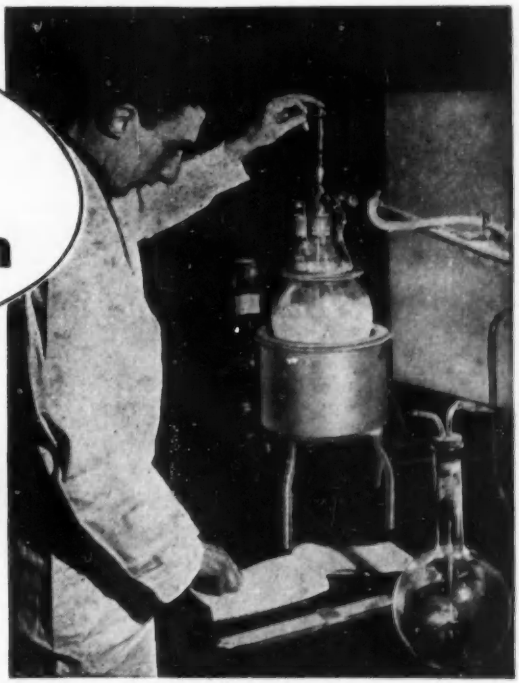
Incidental information

No. 9

items of interest from our laboratory notebooks



A modern touchstone.—***p*-Diethylaminobenzylidenerhodanine** will detect 0.2 microgram of gold in biological materials. (**Anal. Chem. 23**, 653 (1951).) Why look for gold in blood? Because rheumatoid arthritis is treated with gold compounds. Where does one obtain the reagent? From Hopkin & Williams Ltd. It is our Code 3769.5.

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o-[2-(2-Hydroxy-5-sulphophenylazo)-benzylidene hydrazino] benzoic acid has a long name, but it makes short work of the determination of zinc and copper when they are present together. It is just a matter of pH adjustment. The method is in **Anal. Chem. 26**, 1345 (1954). The reagent is on our 'Z' shelf (Z for 'Zincon'). H & W Code 9159.

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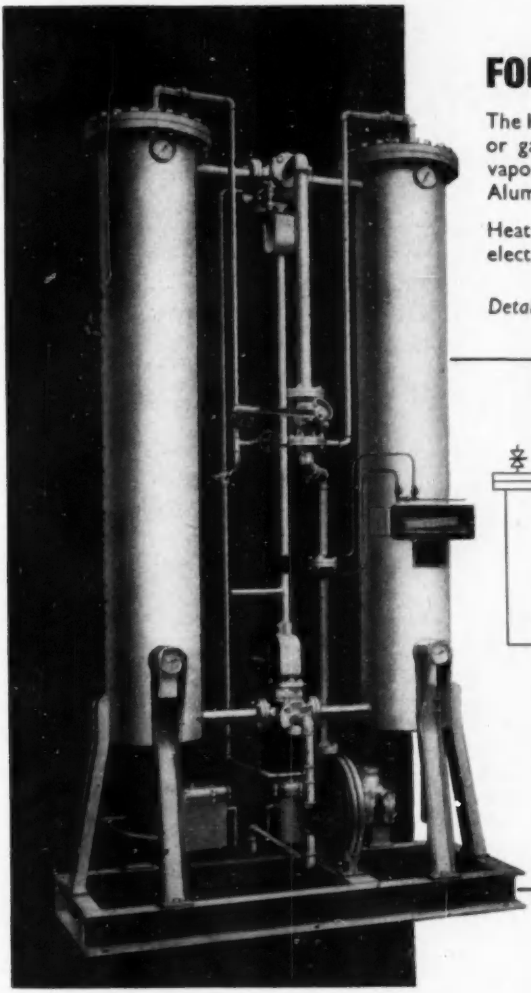

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Heat for re-activation can be supplied by electricity, towns gas or steam as desired.

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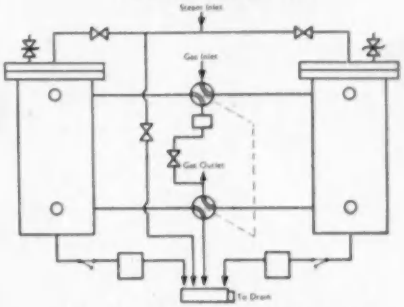

The flow diagram is of a typical instrument air dryer arranged for steam re-activation.
No electric power or circulating fan is necessary.

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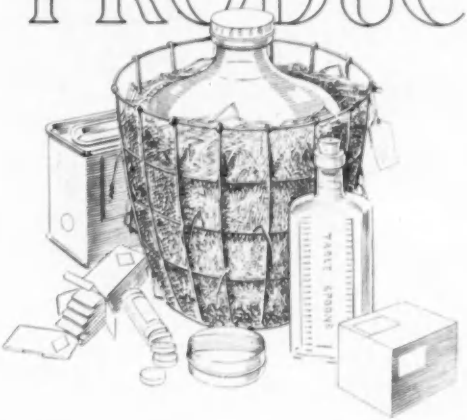
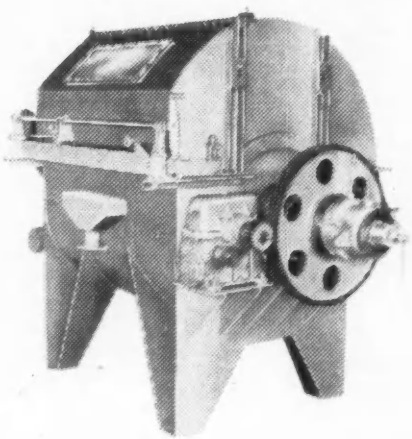


– there's a filter behind them!



Many chemical products and pharmaceutical goods of all kinds are typical of the numerous products about which one can say " there's a filter behind them."

The filter used is, frequently, a Paxman Rotary Vacuum Filter ; units of which are an integral part of the huge chemical industry of this country.

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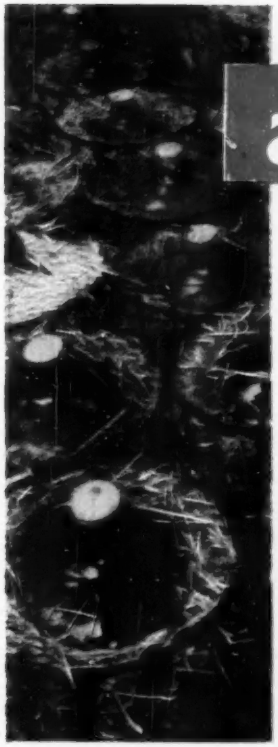

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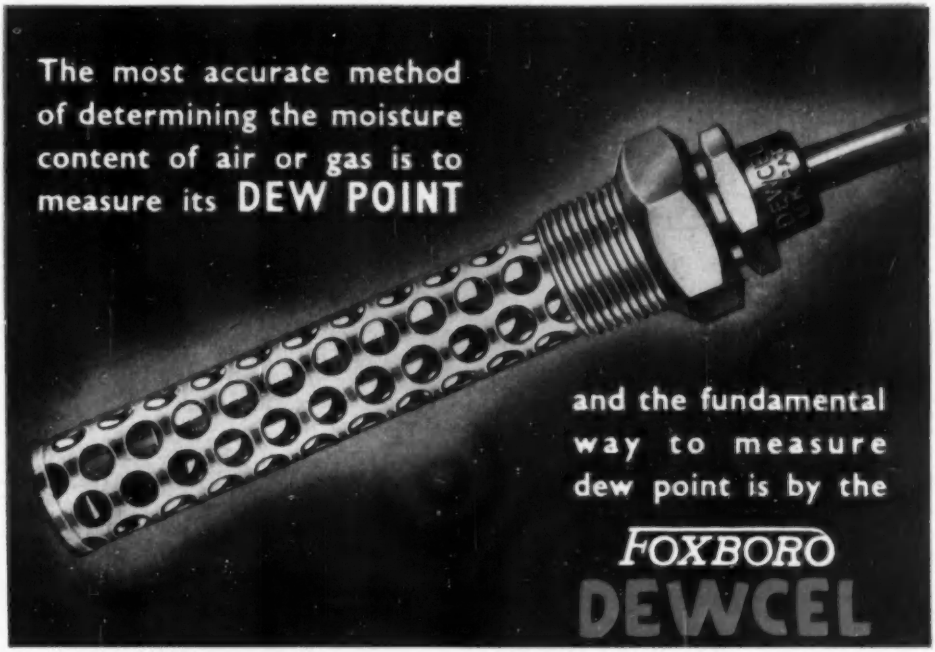

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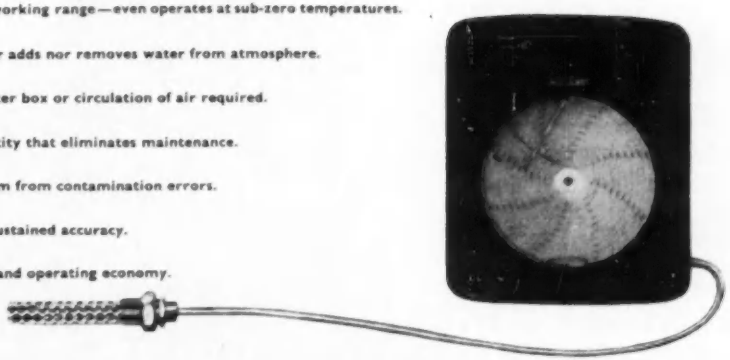

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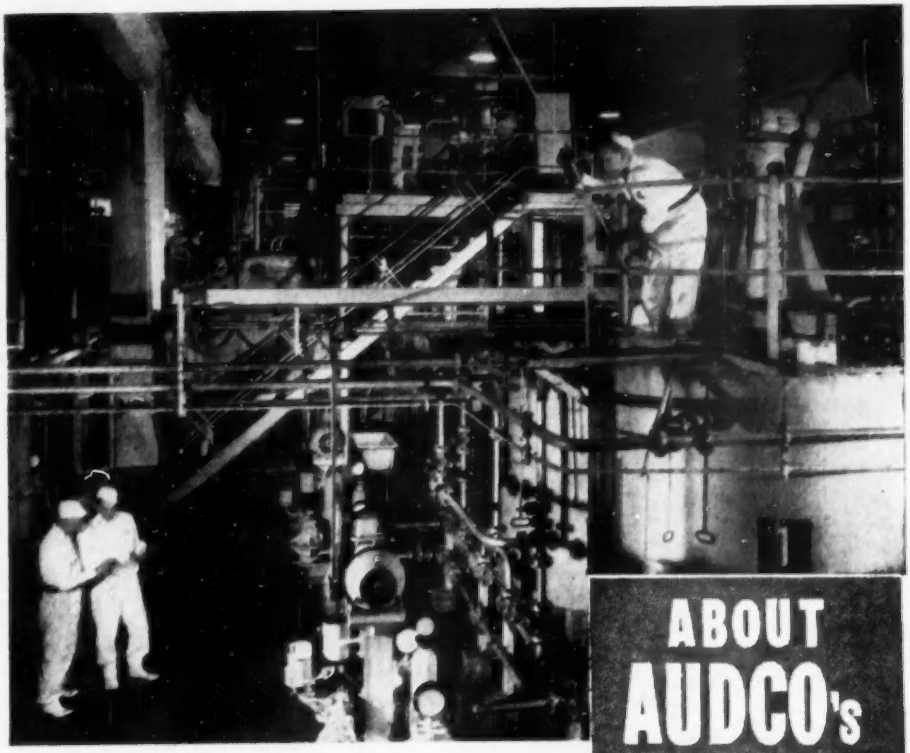

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The above photograph illustrates Audco lubricated valves installed at the British Atomic Factory at Springfields.

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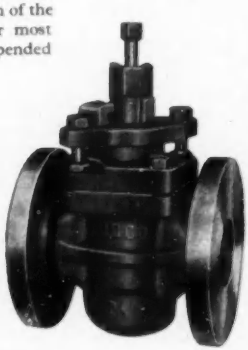


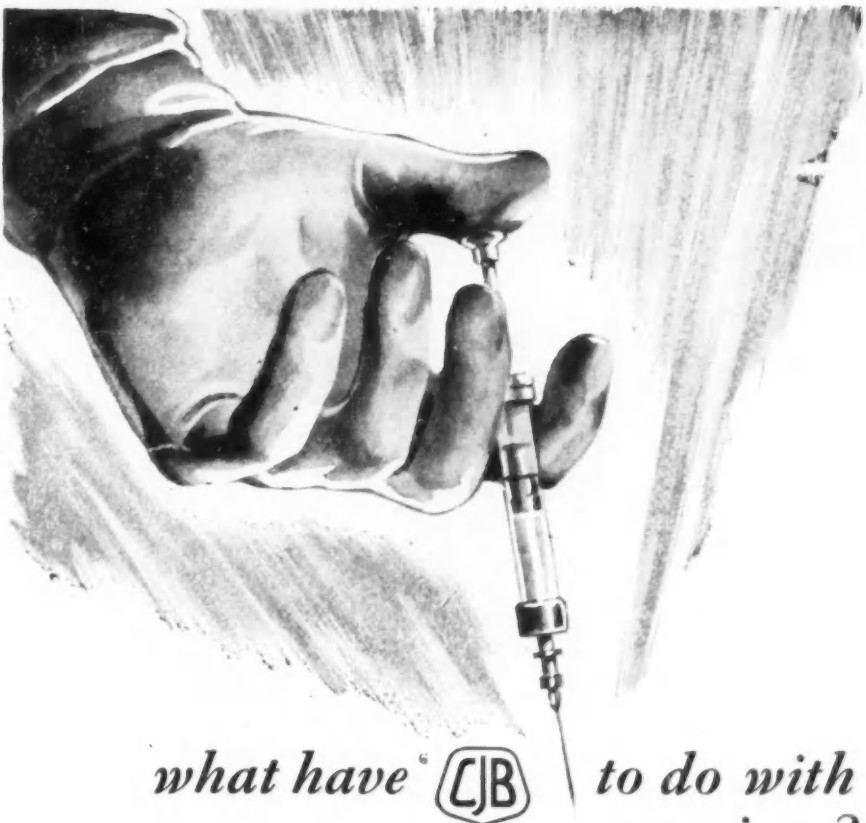
AUDCO MANUAL

The Third edition of this valuable publication has just been printed. It was first published in 1945, the second edition was 1949 and ever since its first issue it has been a prized possession in technical offices, and is a personal issue. It deals with the factors controlling the selection of materials, services and lubricant recommendations.

ATOMIC ENERGY

Britain leads in the industrial uses of atomic energy and while many of the processes are still on the secret list, the British Ministry of Supply and Central Office of Information in their book "BRITAIN'S ATOMIC FACTORY," release some details. Pictures in it show clearly many Audco valves in operation. Thus, while we may not know the exact service, we do know Audcos are helping to keep Britain in the forefront of Atomic Development.

AUDLEY ENGINEERING CO. LTD., NEWPORT, SHROPSHIRE



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Number 1905

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BOUVERIE HOUSE · 154 FLEET STREET · LONDON EC4

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CONTENTS . 14 JANUARY 1956

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Chemicals in 1956

ON the whole, the chemical industries had a very good year in 1955. Industrial production broke new records and the chemical industries kept pace with the demands made on them. The basic importance of all types of chemical products to the manufacturing industry has led to a heavy flow of orders throughout the year. The chemical industries have expanded to meet these orders. There is every indication that expansion will continue into the new year.

However, everything in the garden is not lovely: the country's economic position is precarious. Our troubles in 1955 arose from a combination of causes: over-investment led to excessive imports at a time when raw materials prices were high: buoyant home demand diverted many goods away from export markets: foreign competition became more intense: and although there were record quantities of goods in the shops, there was even more money about, and so prices rose. Some of these difficulties have lessened: notably, import prices have receded. But there still remains the lop-sided balance of our gold and dollar reserves which tilted so alarmingly in the wrong direction that the Government decided it was necessary to supplement the credit squeeze (which took longer to become effective than had been expected) with further restraints on the economy. These efforts will undoubtedly have a delayed action result in 1956. After a national spending spree following the autumn budget, when many retailers were still selling goods at pre-budget prices, traders predict a steady decline in consumer demand.

It was in home trade that chemicals played a major role in the industry's success story for the year: it was the domestic market that demanded an unhealthy share of the industrial output. There is a danger of new production capacity, scheduled to come into operation next year, not being fully employed. This could cause serious trouble unless the easing of the pressure on home demand is matched by an increase in exports. On the whole, though, the latest Government moves seem more likely to encourage the dampening down of demand at home without stimulating sales to overseas markets. There is no reason why the first should automatically bring about the second. Nevertheless, exports will be more than ever vital.

Gloomy though these prospects may seem, the clouds have their luminous linings. The latest figures confirm that home chemicals continue to be well supported by foreign demand. Total exports of chemicals in the first 10 months of 1955 were valued at £192,600,000—an increase of £24,300,000 over the figure for the corresponding period in 1954. The pigment, paint, varnish, pharmaceutical and explosive sections of the trade were largely responsible for this commendable increase in export earnings: each recorded about £3,000,000 rise.

Certain sections of the chemical industry can count on continued prosperity in 1956 with record levels of pro-

duction: the prospects in plastics and synthetic fibre industries could not be brighter. The year just beginning should see a heavy demand for nylon and Terylene by both the export and home markets. British nylon is now the cheapest in the world and later in the new year a new fabric, Acrilan—a nylon material combining stretch and bulk qualities—will probably sweep the market.

The plastics industry has a virtually untapped potential market and producers with foresight are confidently planning new plants to expand output and meet overseas competition. In the first six months of 1955, total output was almost 22 per cent higher than in the same period of 1954. Well over half the total rise can be accounted for by the advance in production of polythene and pvc. Most manufacturers expect a 15-20 per cent rate of advance throughout the next five years, and there are several schemes under way for further major advances in British production. These materials have a great future and if British manufacturers are prepared to exploit their products with resource and energy, the plastics industry should have an outstandingly good year ahead.

Following this bright outlook for plastics comes the less secure position of the heavy chemicals, particularly the maid-of-all-work in the chemical industry, sulphuric acid. Sulphuric acid and sulphate of ammonia are indispensable ingredients in many industrial processes and products—paper, rayon textiles, paints, leather goods, soaps and detergents, drugs and pharmaceutical preparations. Most of these products find their way on to the domestic market. If home markets are dampened by the Government's measures, the effects might be somewhat repressive on the chemical industry. This would be ironic after the near-panic rush to increase our sulphuric acid supplies in the post-Korea phase.

However, the demands of the domestic market must not be over-emphasized. The largest single user of sulphuric acid and nitrogen is the fertilizer manufacturing industry, which uses about one-third of the British chemical output. The first few months of 1955 saw a heavy demand at home and abroad for fertilizers, but the seasonal decline proved to be more than usually steep and the trade suffered a drop in export earnings of close on £2,000,000. The prospects for 1956 are, at the moment, optimistic and interest is still being shown in forward buying for use in the spring. Prices increased last year, but they are expected to ease during the coming months as sulphur supplies are now much improved. There is, however, one other vital ingredient in fertilizers which has suffered from political fever in recent months: phosphate rock supplies come mainly from French Morocco and the interruptions of shipments because of internal unrest or actual damage to the mines would have serious effects on the fertilizer market. At the moment the worst seems to be over, but the problems are by no means solved and the situation will need to be watched closely in 1956.

The weather was kind to us in 1955. Building and construction work went on undiminished well into the autumn, and the tar products flourished accordingly. The weather cannot be forecast for the next 12 months, but the industry has a good start in 1956. There is a consistently strong demand for paints and there is every indication that this demand will continue.

Thus the chemical industries may face difficulties in some sections, but the general outlook is one of brisk business and continued expansion. Heavy chemicals have a good market and prices should be firm. There is a guaranteed market in the armaments industry as in present world conditions there is no likelihood of a major disarmament programme.

The future success of the chemical industry lies in the balance of trade: exports are vital to the economy of the industry and the economy of the country alike. The task of maintaining Britain's exports at a sufficient level to provide us with food and raw materials will fall more and more on the new industries—electronics, plastics and synthetic textiles. These industries have in turn to face ever-growing competition from overseas. In many of these new industries, chemicals are vitally concerned, and the growth of these industries is at once a challenge to the country and to its chemical industry.

Notes & Comments

Isotopes Astray?

THE first week of the New Year produced a head-lined scientific scare with the six hours' hue and cry in London for a missing capsule of radio-isotopic iridium. Finally the lead-encased capsule was found in the building company's yard from which it had supposedly disappeared—instead of being in its authorized locked shed it was in a paint shop attached to the yard. Alarm during the search must be regarded as justified, for anybody innocently handling the capsule could have suffered serious radiation effects. *The Daily Telegraph* was prompted into a cautionary leader. The increasing employment of radio-isotopes in research and industry has created new kinds of risk. Should these new risks be treated any less lightly than those associated with toxic drugs or hazardous machines? It may be certain that the scientists who use radio-isotopes in experimental work and testing are fully aware of the potential dangers and therefore take every appropriate safeguard—but this is equally assertable for pharmacists who handle poisons and engineers and skilled operators who deal with machines.

Voluntary Action

THERE surely should be strict precautions to prevent radio-isotopes from being handled by uninformed persons. *The Daily Telegraph's* argument cannot be dismissed as over-fearful or pernickety. It is sound and sensible; and this false alarm in London last week is a good enough example. The invisible and unfelt presence of radiation obviously enhances the dangers—even highly poisonous substances often have repellent tastes that would discourage ignorant consumption. Nor can it be forgotten that some scientists tend to be exceedingly lax in dealing with known risks; familiarity can readily breed a dangerous sort of contempt. There seems much to be said for this Fleet Street plea for legal regulations to ensure the 'safe use and custody of radio-isotopes'. If the introduction of strict regulations creates bothersome red tape and formalities for busy scientists—as no doubt it would—those who are at present responsible for radio-isotopes will be well advised to check their security arrangements. Voluntary action may obviate the need for compulsion. Another radio-isotope 'disappearance' is almost certain to stimulate the demand for legislation.

Science Students

AS the barriers that have barred the way of many to a higher education have been swept aside in the last three decades the disclosures made at the recent conference of the Science Masters' Association in London are disturbing. Figures given at this conference revealed that universities in this country—excluding Oxford and Cambridge—were rejecting between 3 and 30 per cent of their science students at the end of the first year. As Dr. E. R. Roberts of the Department of Inorganic Chemistry of the Royal College of Science said: 'It is serious wastage at a time when the future of the country depends largely on an adequate supply of trained science workers'. With the era of automation about to invade industry, time is the one thing that can be least afforded, for industry, already ill-balanced in many instances through lack of scientific workers, will need to be on an even keel when embracing the inevitable age of automation. Dr. M. J. S. Dewar, professor of chemistry at Queen Mary College, London, who agreed with Dr. Roberts that many students had reached their intellectual ceiling by the time they had left school, hit the nail on the head when he laid the blame for this on the general certificate of education which causes science to be taught in schools, not as an intellectual discipline, but as a cramming for a memory test. Schools are tied to a tyranny of an examination that has not changed fundamentally for 70 years, he claimed. While the proportion of first year failures is far too high, it is equally as obvious that the univer-

sities and the schools could lower the proportion of failures; the universities by giving students more help during the period of transition, the schools by advancing more detailed information about the candidates they were sending to universities, and by ensuring that students were not choosing the wrong subjects for study.

Paper Talk

GOOD copies of typing or writing without the use of carbon paper have been possible in the US for just over a year. An emulsion-coated paper achieving this has been selling at the rate of 1,000 tons a month there. The process is said to be the result of 10 years' research by an American office machinery company. The emulsion is at present being imported under licence here and supplies of this paper (known as NCR—no carbon required) are being produced. During 1956, however, a British plant will be manufacturing the emulsion and production of the coated paper will expand substantially. It is reported that sole rights to sell the paper and also the production of the emulsion will be retained by the British branch of the US company which developed this project. We have not come across any chemical account of the emulsion and its *modus operandi*, but this certainly seems to be a case where US science has been 100 per cent ahead in an entirely new technological development. The number of good copies obtainable is six for ball-point pen writing, eight for typing, 12 for electric typing. The competitive threat to carbon paper is scarcely trivial.

OCCA Dinner Dance

THE biennial dinner and dance of the Oil & Colour Chemists' Association will be held on Friday 2 March at the Savoy Hotel, London WC2.

The Association's guests this year will be the president of The Royal Institute of Chemistry, Dr. D. W. Kent-Jones; the president of the National Paint Federation, Mr. R. C. Sissons; the president of the Society of British Paint Manufacturers, Mr. C. D. O'Sullivan; the president of the Paint Research Association, Mr. D. L. Annand; the president of the Chemical Society, Prof. W. Wardlaw; the president of FATIPEC, Mr. E. V. Schmid; the president of the Printing, Packaging & Allied Trades' Research Association, Sir Guy Harrison; the president of the Society of Dyers & Colourists, Mr. F. Smith; and the president of the Birmingham Paint, Varnish & Lacquer Club, Mr. J. J. Pemberton.

Single tickets are priced at two and a half guineas each and non-members wishing to attend can obtain application forms from R. H. Hamblin, general secretary, Oil & Colour Chemists' Association, Memorial Hall, Farringdon Street, London EC4.

QVF Limited have recently completed their third large order for 18-in. diameter glass pipe and fittings for research work at the University of California. Mr. J. G. Window, QVF sales director, said: 'We secured orders for this equipment against strong American competition. Apparently the quality and price of our products are sufficiently attractive to warrant the Americans placing the order with a British firm.' The photograph shows the pipeline being packed for shipment to the US

GREETINGS . . .

G. F. WILLIAMS, Esq.

(Chairman, The Association of British Chemical Manufacturers)

IT is my pleasure and privilege as chairman of the Association to convey New Year greetings to our friends both within and without the industry.

G. F. Williams

The year 1955 has been a good one for Britain's chemical industry. It has reached new peaks both in output and in its sales overseas. The industry has also achieved a record in having spent over £500,000,000 on new capital projects since 1948. This vast sum of money has been spent not only on modernization but also on financing the manufacture in the UK for the first time of many new chemicals. The petroleum chemicals industry is now firmly based and continues to expand and we shall shortly be entering the synthetic rubber field. The production of man-made fibres, antibiotics and plastics were notable highlights in 1955.

It may be dangerous to try to predict the future but the British chemical industry faces it with confidence and granted nothing unforeseen arises, 1956 should also be a successful year. It is, in addition, notable for it marks the centenary of the discovery of the first synthetic dyestuff by William Perkin, from which developed the organic chemical industry.

The British chemical industry will be on show to the world at this year's BIF at which over 100 firms will be represented and where results of British research will be on view. Over £13,000,000 is being spent annually on research, productivity is rising and is now 50 per cent higher than in 1948; these two facts alone are indicative of the industry's will to continue its successful progress.

I should like, on behalf of the chemical industry, to wish you all success and prosperity in 1956.

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W. J. HOOTON, Esq., A.M.I.Mech.E.

(Chairman, British Chemical Plant Manufacturers' Association)

IT is a privilege as chairman of the British Chemical Plant Manufacturers' Association once again to extend New Year greetings on behalf of its members to all their friends in the chemical and allied industries.

During last year important decisions were made by the Association, in consultation with the Association of British Chemical Manufacturers, regarding chemical engineering research. These decisions have already been announced and I look to the steps which BCPMA is taking, by making better known what research is being conducted in the Universities and elsewhere, to create an increasing awareness of its applications. I also see in them the means to promote a much freer interchange of experience and non-confidential information between firms which ultimately must be of great and lasting benefit to all concerned in our industry.

W. J. Hooton

In 1955 the British chemical plant industry continued to demonstrate its competence in all spheres of its activities. Good use was made of the complete contracting services offered by a number of its firms and the fabricating skill within the industry was amply illustrated by some of the large units built to equip the new nuclear power sta-

tions. It augurs well for the future that this competence is backed by many splendid new works which, over the last few years, have replaced the old congested shops and provide production facilities which are the equal of anything in the world.

I look forward to 1956 with every confidence. May it bring prosperity to THE CHEMICAL AGE and all its readers.

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G. V. SIMS, Esq.

(Chairman, the Council of British Manufacturers of Petroleum Equipment)

AT the commencement of the New Year should we not all look to the undoubted opportunities open to British manufacturers in the Dominion of Canada? At the present time, British imports to that great Dominion have fallen to only 8½ per cent of the total imports, a decrease of about 10 per cent compared with orders immediately before World War II, and yet there is probably more opportunity and a great welcome in Canada for those firms who see fit to tackle that market.

G. V. Sims

It is true that competition is fierce, particularly from the US but, in the opinion of one individual, it is not over hard to meet. The opportunity of earning badly needed dollars for this country is there and, taking into account that the market for all kinds of products in Canada at the moment is exceptionally satisfactory, it is a great pity that more effort is not being made to correct the dwindling export trade. I personally believe that the Canadian people welcome the right type of individuals from this country.

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C. M. HILL, Esq.

(President, the Association of British Pharmaceutical Industry)

THE year 1955 was notable for several events of special interest and importance to the ABPI and the pharmaceutical industry. In January of last year, the Association celebrated the 25th anniversary of its formation and published a commemorative booklet recording its history, achievements and present constitution.

At a reception given by the Pharmaceutical Society of Great Britain in May, an exhibition was staged, at the request of HRH the Duke of Edinburgh, who was the chief guest, illustrating the contribution of the pharmaceutical industry to medical and veterinary science.

C. M. Hill

Despite an intensification of overseas competition, the industry has made good progress in the export field and it is expected that the record export figure of £34,000,000 in 1951, which was almost reached in 1954, will have been exceeded in 1955. The home market for prescription drugs is largely confined to National Health Service requirements and the quest for economies in NHS expenditure at the expense of the industry has caused anxiety and uncertainty. It is satisfactory to record, however, that as a result of an investigation into the 'levels of earnings' of secondary manufacturers and wholesalers of standard drugs, the Health Departments concluded that the prices of unbranded standard drugs were not excessive. The more complicated problem of satisfying the Departments on the reasonableness of the prices charged for branded medical specialities is still under discussion with the Association. The aim of the Association in 1956 will be to clear away these uncertainties and to secure for the industry the freedom and incentives necessary for progress in research and expansion of export trade.

In sending New Year Greetings, through your columns, to members of the ABPI, may I also add my good wishes to all those engaged in the chemical and allied industries.

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A. E. SKAN, Esq.

(Chairman, British Plastics Federation)

LAST year, at this time, I expressed the belief that 1955 would be an outstanding year for the plastics industry and in looking back over the past 12 months I feel this belief has been more than justified.

A. E. Skan

Although final figures for 1955 are not yet available, the known results are very satisfactory. Total production for 1954 equalled 274,000 tons; for the first half of 1955 the figure was 162,000 tons, an increase of 22 per cent on the first half of 1954 and 15 per cent above the total for the second half of that year. On this basis, total production for 1955 should show an increase of at least 20 per cent on 1954. Exports for the first 10 months showed an increase of £1,750,000 on the same period of the previous year. When it is remembered that 1954 was itself a record year, I think we can be satisfied that the plastics industry has a very promising future.

The Third British Plastics Exhibition, which was held in June, was a complete success and attracted a record number of foreign visitors.

The past year was a memorable one for the British Plastics Federation which celebrated its 21st anniversary. At their annual luncheon in April, the members had the honour of entertaining His Royal Highness, The Duke of Edinburgh.

The activities of the Federation have increased considerably owing to a steady rise in membership and the demand for additional technical committees covering an ever-widening range of materials. One of the outstanding developments of the year has been in connection with glass fibre. A successful convention was held at Harrogate and although there is still much to be learned about this material it is believed to have great possibilities.

The Federation will be holding a convention at Torquay in September 1956, at which it is hoped all sections of the industry will be represented.

In offering my good wishes for a prosperous New Year to those in the plastics and allied industries, I do so with every confidence that they will be fulfilled.

Lt. Col. S. J. M. AULD, C.B.E., M.C.

(President, Institute of Petroleum)

DURING the year 1955 the Institute of Petroleum has engaged in a number of important activities, not the least of which was the organization of British participation in the Fourth World Petroleum Congress. This Congress, which was held in Rome in June, attracted nearly 4,000 participants from all parts of the world and from all spheres of activity in the petroleum industry. It is worthy of recall that the institute (then the Institution of Petroleum Technologists) was in 1933 responsible for organizing the First World Petroleum Congress and continues to provide the secretariat for the Permanent Council of World Petroleum Congresses.

In the sphere of standardization the institute was also very active and advantage was taken of the presence in Europe of representatives of the Co-ordinating Research Council of the US to arrange special meetings to consider the important subject of the engine testing of lubricants. The institute also participated in the meetings of the International Standards Organization Technical Committee 28 on Petroleum Products. One result of this meeting was the recommendation to submit for international acceptance the ASTM/IP Petroleum Measurement Tables and the Motor and Research Methods for knock-rating of motor fuel.

Lt. Col. Auld

Towards the end of the year, arrangements were completed to provide the institute with a permanent headquarters in London. A building has been purchased and a building fund is to be inaugurated.

In the coming year, the subject of 'Essential Factors in the Future Development of the Oil Industry' will be discussed at the Summer Meeting. The Hydrocarbon Research Group is also arranging that the development and application of chromatography as a method of chemical analysis should be discussed at a three-day meeting.

W. G. HISCOCK, Esq., B.Sc., Ph.D., F.R.I.C., F.I.I.A.

(Chairman, Association of Chemical & Allied Employers)

THE chemical industry has, like all other British industries in 1955, had in its industrial relations to face the difficult situation of labour shortages in a period of steady inflation. Through the Chemical and Allied Industries Joint Industrial Council a wage advance was agreed upon in January and this, together with the additional earnings made possible by bonus schemes, plus rates and some overtime, made a high level of earnings possible throughout the year and there has been no discord between employers and workers of any significance. The industry continues to give great attention to the protection of the health of its workers and the prevention of accidents, and statistics collected by the association show that, contrary to beliefs occasionally expressed in certain quarters, the record of chemical firms in the matters of sickness and accidents is markedly better than industry as a whole.

Dr. Hiscock

In the latter part of the year, applications were made by the trade union side of the Joint Industrial Council for a 40-hour week and for another week of holiday with pay in addition to the two already given by the Joint Industrial Council and the six paid public holidays. The employers took the view that in an industry where the nominal weekly working hours were already exceeded and where there were no available reserves of labour, it was inappropriate to assent.

Two years' operation of the JIC Training Scheme for Chemical Plant Operators has now been completed, and 250 adults have qualified. The same number of youths are under training, of whom some have now passed the Intermediate Examination in Chemical Plant Operation. New registrations for the third year number about 400.

In the field of employment it is expected that the stresses and strains which operated in 1955 will continue, but the Joint Industrial Council, which is one of the few which has continued actively in existence from the time of the Whitley Report, continues to provide the machinery for the amicable discussion of problems as they arise and there is every confidence that the New Year will be as free of discord as the old. May it be a prosperous one for members of the Association and all readers of THE CHEMICAL AGE!

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STANLEY ROBINSON, Esq.

(President, the British Wood Preserving Association)

DESPITE the close proximity of the railway strike to the dates fixed for the annual convention, over 200 delegates assembled at Cambridge in June. Among the papers presented was one of particular interest by Mr. J. G. Savory, principal Scientific officer in the Section of Mycology at the Forest Products Research Laboratory. This dealt with 'The Role of Microfungi in the Decomposition of Wood'. A further short paper on 'The Decomposition of the Cell Wall by Micro-Organisms' was given by Dr. W. K. F. Liese of Freiburg University. Arrangements have been made for the 1956 Convention to be held at Cambridge, 3-6 July. Seven papers will be presented and among these will be papers from the Forest Products Research Laboratory dealing with the work of the Timber Borer Research Unit in West Africa, the Fire Research Station on recent developments in connection with fire retardants, and the Commonwealth Institute of Entomology on termites in relation to wood preservation.

S. Robinson

During 1955 over 60 lectures were arranged on timber preservation for technical colleges, professional associations and institutions, including nine for the Ministry of Works at various centres throughout the country. As always, there has been a big demand for the Association's leaflets including the wood preservation supplements and the wood preservatives register. A new

leaflet dealing with creosote has now been prepared and further leaflets on water-borne and organic solvent type preservatives are in course of preparation. Apart from distribution of literature the officers of the Association have dealt with over 2,000 enquiries relating to timber preservation throughout the year.

Several meetings have taken place during the year with representatives of the Timber Development Association and a comprehensive report on Timber Preservation has now been prepared which will be issued as a joint publication by the two associations in 1956.

Another feature of the year has been the setting up of a Service Records and Service Tests Committee. The members of this body are all people not directly interested in the sale of any specific proprietary preservative and include representatives of the British Transport Commission, Central Electricity Authority, National Coal Board (Timber Branch), Imperial College of Science and Technology and the Timber Development Association.

It is also pleasing to record that during the year a considerable number of new members have joined the Association, including several Government research organizations from the Commonwealth and Overseas countries.

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J. B. VICKERS, Esq.

(President, Association of Tar Distillers)

THE work of the Association of Tar Distillers is closely linked with the chemical industry and I am pleased to take this opportunity of thanking that industry for its continued co-operation both as regards individual firms and through the Association of British Chemical Manufacturers during the past year.

J. B. Vickers

It is in the provision of raw materials for essential industries that the tar distilling industry underlines its importance. In its research, methods of production and commercial arrangements, it makes every effort to support the remarkable and continuing growth of the British chemical industry.

I am particularly pleased to send this message as president of a trade association. It is to be hoped that when there is so much misunderstanding and mis-representation concerning the value of trade associations and the nature of their operations, it will be realized what an important part they play in the promotion of British industry.

May I send the good wishes of my association to your journal and wish it every success in the coming year, and my personal greetings and expression of goodwill to all our members?

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F. W. SUGDEN, Esq.

(Chairman, Association of British Insecticide Manufacturers)

IT is with pleasure that I extend, on behalf of the members of the Association of British Insecticide Manufacturers, their good wishes for 1956 to all readers of THE CHEMICAL AGE.

F. W. Sugden

The war between man and those who would destroy his crops, whether these be insects, diseases or weeds goes unrelentingly on, and it is only by the continued progress in the science of crop protection that the harvests of the world can be successfully gathered and utilized. The members of the Association continue to play a major part in providing those products and services for all parts of the world which so materially assist in providing an adequate food supply for an ever growing world population.

While the rate of introduction of new crop protection agents has been somewhat reduced in comparison with the early post-war years, steady progress has been maintained during 1955. Research and technical development has been aimed at finding better and safer products. Close co-operation has been maintained with the Ministry of Agriculture, Fisheries & Food, particularly with regard to the safe application of the newer products and the preparation of specifications

and methods of analysis for use in the Joint Voluntary Crop Protection Products Approval Scheme.

A very successful Insecticide & Fungicide Conference organized by the Pesticides Group of the Society of Chemical Industry, was held in November, when papers were presented by eminent personalities of the universities, research institutes and the industry. The stimulating discussion which followed the papers augurs well for the future of crop protection.

A less spectacular but no less important step was taken during the year when meetings, arranged by the International Standards Organization, were held in London to discuss the possibility of agreeing internationally common names for the complex chemicals used as pesticides. Eight nations were represented at the meetings and agreement among them was obtained on a number of common names. Many of these names are already familiar to home users of crop protection products.

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J. T. PROCTER, Esq.

(Chairman, the Superphosphate Manufacturers Association)

IN thinking of all those who contribute towards the manufacture of the round million tons of superphosphate which is annually applied to the farmlands of the United Kingdom (chiefly as a main constituent in compound fertilizers), one's mind ranges from the rock phosphate mines of Morocco, Algeria and Tunisia, to the pyrites mines of the Rio Tinto and Cyprus; from the dollar domes of sulphur to British anhydrite; from ships, ports and railroads, to process workers, engineers and chemists, upon all of whom our industry relies in making timely delivery of its product.

That the industry regularly achieves its purpose is not only a tribute to itself, but to the goodwill of all these services, even though from some this is obtainable only at a dangerously rising cost. Since the selling price of few chemicals comprises so high a proportion of raw material and transport costs as superphosphate, farmers have inevitably felt, and must continue to feel for some time to come, virtually the full impact of last year's steepening freight market.

Although fertilizer research reaches for yet higher productivity, and even for greater efficiency in utilization as means of offsetting costs, the paramount need of the superphosphate industry in the New Year is for political settlement overseas, especially in Morocco, and a stable freight market. Nor are we alone in calling for vastly improved port services, both human and mechanical, without which not enough of the best ships of the world are ready to carry the nation's imports and exports at competitive prices.

Thus our New Year message to you and your readers, who are all directly or indirectly faced with the effects, is not only one of good wishes for the continued progress of all concerned in the Chemical Age in its widest sense, but at the same time a spoke in the wheel for more general appreciation of the urgent need to solve the difficult problem of our sea ports.

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C. F. V. BLAGDEN, Esq.

(Chairman, the British Chemicals & Dyestuffs Traders' Association)

IT is my privilege and pleasure, as chairman of the British Chemical & Dyestuffs Traders' Association, to extend New Year greetings to all our friends and to wish THE CHEMICAL AGE every success.

The dawn of another year is a reminder that this is the time to renew our efforts and to re-approach our problems in the light of experience, fortified with the traditional courage and resourcefulness of the British merchant.

On all sides we hear of thriving industries. Certainly, the demand for chemicals in 1955 reached a high level and we regard with satisfaction the expansion in the volume of chemical exports. Yet, we must go out for higher standards, for if we are to keep pace with developments, the United Kingdom must sell more in the competitive world markets and take its full share in a rapidly expanding world trade.

Our approach to this task depends, fundamentally, on individual enterprise, but our collective interests are best promoted by co-operation through the representative Association of the trade and its work deserves the utmost support of all chemical merchants.

The field of chemicals has now extended

into many industries and there is a continual growth of new products. It should not be overlooked that it is the merchant who provides that essential link between the producer and the user of chemicals, bringing all types of new materials to the aid of modern industry.

Looking ahead, it becomes more and more evident that quality of products and efficient marketing are essential if we are to maintain our position as a leading world supplier.

I send my best wishes for the prosperity of all.

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E. A. S. ALEXANDER, Esq.

(President, Glass Manufacturers' Federation)

IT was with pleasure that I accepted the editor's kind invitation to address a message to his readers. Within the lifetime of most of us a great chemical industry has been created that has materially added to the scientific and commercial prestige of Britain.

E. A. S. Alexander

We live in an age of rapid scientific development, and more and more the lives of every one of us is becoming dependent upon original work in the laboratory and its development in the plant. It is not always realized, however, how at all stages, from the idea to its fruition, the interests of the chemical industry and the glass industry are interwoven. Technological development in the science of glass melting has been rapid over the past 40 years and the industry owes much to the chemists and physicists whose experiments have led to the refinement of existing formulae and the development of new glasses. In another way, the glass industry serves the chemical industry, by providing much of the intricate apparatus needed in the laboratory, and the containers for many of the wide range of chemical products now produced.

In stressing this close link between our two great industries I would add that my industry has expressed its faith in scientific investigation by the creation in April of last year of the British Glass Industry Research Association. This association has taken over the industrial investigations previously undertaken by the Department of Glass Technology at the University of Sheffield, thus enabling the latter to concentrate on pure research and the training of glass technologists.

In looking forward to this new year may I express my confidence that our two industries will not only consolidate our development, but will derive great benefits from our mutual interdependence.

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L. J. HUGHES, Esq.

(President, Association of British Organic Fertilisers Ltd.)

IT has been a difficult year due to increased prices, high freights and labour disputes. There has been a steady demand for most organics but owing to the above difficulties merchants have declined unnecessary risks and stocks have been lightly held which has tended to increase competition for the limited stocks available.

Our industry is dependent mainly on the horticultural and market gardening trades where the value of organics has been proved by long experience. We cannot expect to compete with inorganics in the farming trade as we could not supply the vast quantities required in this fertilizer-conscious age; furthermore, inorganics are subsidized and farmers can only afford organics where they are sufficiently cheap to compete or absolutely essential for the purpose required such as when the keeping qualities and flavour of the product are the main concern.

L. J. Hughes

Your association is doing its utmost to bring these points to the attention of the trade and we have published a handbook on organics, the first of its kind, which has met with a worldwide demand showing that there is a universal call for more knowledge on this important subject. You may rest assured that we shall do our utmost to satisfy this demand.

This year we took a most important step by staging our first overseas convention. It was a great success and we owe a debt of thanks to the Dutch Ministry of Agriculture for their co-operation. Our members were given a splendid insight into Dutch agricultural methods with particular attention to fruit farming and land reclamation. We hope to repeat the experiment.

I trust that all members will continue to support the Association in its endeavour to promote their interests and I look forward to another year of progress.

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H. GOSLING, Esq.

(Chairman, British Colour Makers' Association)

THE British Colour Makers' Association is a body representing the majority of pigment colour manufacturers in this country. It endeavours to stimulate the improvement in both quality and production, the former by being associated with the Paint Research Station at Teddington, and the latter by affiliation with the Association of British Chemical Manufacturers, assisting in the development of new production techniques. Consequently the industry is steadily growing, and new and improved products are being introduced into the market each year.

H. Gosling

Colour is finding new and increasing uses and the knowledge required to meet the more exacting demands necessitates a scientific and technical control, far greater than was the case a few years ago. The need for more scientifically trained staff is as acute as in many similar industries.

Progress can be continued, however, only by pursuing the goal of new and better colours and increased productivity so that the British colour makers may offer at home and abroad the best quality and the best value. In sending my very best wishes to members of the BCMA I would like to express my confidence that the year 1956 will see further improvements in our industry.

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C. D. O'SULLIVAN, Esq.

(President, Society of British Paint Manufacturers Ltd.)

STANDING on the threshold of 1956 may not be the best time to review 1955, for I always think that the characteristics of any particular year can better be assessed when there has been a gap in time, so that they can be viewed in their right perspective.

But looking quickly over my shoulder at the receding year, I feel it would be correct to say that although it will probably not figure in our industrial history as a year of outstanding events, it has certainly been one in which the manufacturer has had to summon all his resources in order to face strong competition both at home and abroad.

This perhaps is not a bad thing, for in the case of keen business conditions, progress in administration, as well as in manufacturing processes, must of necessity be made.

Looking in the direction of 1956, I can say that, although I am not conscious of any undue optimism, I feel that if only our national and international finances could be placed on a firmer footing, and home consumption be allowed to find its natural level, the business world would revolve with reasonable prosperity, in which the chemical industry should take its full share.

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J. N. HOPE, Esq.

(Chairman, Association of British Sheep & Cattle Dip Manufacturers)

ONCE again it is a great pleasure to have the opportunity of wishing your readers a Happy and Prosperous New Year in which all members of the Association will join me.

Our co-operation with industry and Government has continued during 1955 successfully, and we are particularly proud of our record in the export field where once again the products of our members have been delivered to all corners of the globe.

J. N. Hope

Export prospects for 1956 appear to be reasonable although we feel it is timely to sound a note of warning on the question of rising prices. There is a definite possibility of British chemical products becoming less competitive in world markets if the present tendency continues, and this is again further encouragement for overseas countries to develop their own manufacturing industries.

As the producers of basic chemicals rely for their custom largely on the producers of finished chemical goods, we feel that a greater degree of co-operation between our association and other trade associations will be called for in the coming year.

We have no doubt that this will be salutary and to the benefit of the British export trade.

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R. E. HUFFAM, Esq.

(Chairman, United Kingdom Glycerine Producers' Association)

THE United Kingdom Glycerine Producers' Association is pleased that during the past year, when industrial production reached a new record, it was found possible to discontinue the glycerine licensing system so that, for the first time since before the war, buyers were able to obtain their full requirements promptly.

In the future, it is expected that buyers' demands for glycerine will continue to advance, and that their additional wants will be covered by further increases in synthetic glycerine production, which have been announced by their manufacturers, and from the larger output of the soap industry in Africa and Asia.

R. E. Huffam

On behalf of Association members, I wish everyone connected with our industry and readers of THE CHEMICAL AGE a successful and prosperous 1956.

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F. H. PEAKIN, Esq., Ph.D.

(President, British Acetylene Association)

THE British Acetylene Association, founded in 1901 to promote the industrial uses of acetylene, has seen the production in Great Britain of this material grow from a few thousand tons to the large figure of 50,000 tons per annum, which has brought it into the front rank of organic chemicals in order of magnitude.

F. H. Peakin

This growth has been due to two main causes—to the steady expansion of metal welding and cutting applications which make use of the intense heat of the flame of burning acetylene, and to the much more rapid development of chemical manufactures based upon the synthetical processes which the reactivity of acetylene makes possible.

Acetylene is made in Great Britain from calcium carbide and will, without doubt, be preponderantly so made for a long time to come. For a decade and a half now, carbide has been produced in Great Britain. Imports are, in addition, of greater magnitude than ever, so that the handling and transport of calcium carbide and the generation, handling and use of acetylene are operations carried out on a rapidly increasing scale.

Acetylene is a substance which must be treated with respect since hazards attend its generation and use. As in most industrial countries, the need for co-operation among those who produce and use it is the main *raison d'etre* for an association which not only promotes the use of the gas in a quantitative sense but does everything possible to promote safety and to assist Government and local authorities in arriving at regulations which, at the same time as they aim to ensure a high standard of safety, do not impede the rapid growth of so many important industrial processes based on the use of calcium carbide and acetylene. The British Acetylene Association is in close touch with Continental organizations with a common

interest in such problems; through its membership of the Commission Permanente Internationale de l'Acetylene.

The Association enjoys the support of a large and varied industrial membership to whom the President sends greetings for the coming year and cordial wishes for their continued prosperity.

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G. T. GURR, Esq., F.R.I.C.

(President, the British Association of Chemists)

THE year 1955 has been one of further expansion in the British chemical industry and numerous other industries dependent on chemical processes. Our apparent prosperity and growing exports arise from this and it is not too high a claim that much is due to the individual efforts by chemists. Full employment of chemists has been followed by increased production all round. The increased volume of exports is vital evidence that we can still face up to foreign competition, thus making an important contribution to our national economy.

G. T. Gurr

During the year the prestige of the British Association of Chemists and its importance to the chemical profession has grown. Our salary scales have been revised and present a reasonable standard for qualified chemists and their assistants. It is pleasing to experience the large demand for these scales from employers in all branches of industry; they now have recognition by the largest employers and have done much to develop good relationship.

After three years, Hinchley House has proved itself not only a dignified headquarters and place of call for members but a satisfactory investment for our Unemployment Fund which now has reserves of nearly £59,000. In view of the great strength of the fund we have decided to make contribution to the fund voluntary, so that members need not subscribe unless they wish; it is believed, however, that many will still contribute to provide for the possible 'rainy day'.

My New Year message to chemists is to join with your fellow chemists in the BAC. You will find it helpful besides making a practical contribution to the success of our progressive association.

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THOMAS McLACHLAN, Esq., A.C.G.F.C., F.R.I.C., M.I.Biol.

(President, Association of Public Analysts)

AS president of one of the youngest chemical organizations I gladly send my best wishes to THE CHEMICAL AGE and to its readers. The Association of Public Analysts has been formed in order to enable public analysts to play a more important role in the food and drug administration of the country. Isolationism must spell failure in the modern world and public analysts feel that they have a collective part to play not merely as individuals examining a single sample, nor as a collection of analysts discussing among themselves what they feel should be the composition of a sample, but by meeting and discussing with trade organizations what they believe to be the public interest, bearing in mind changes in public palate, changes in availability of raw materials, and, above all, the general welfare and the nutrition of the population as a whole. A number of committees has been formed to investigate the composition of different classes of foods, drugs, and similar commodities and these committees are anxious to meet representative associations of manufacturers, though it will be understood that we are unable to advise individual manufacturers.

T. McLachlan

The association does not hold itself out as a purely scientific society though its work naturally impinges on that of other organizations and we are grateful for the close collaboration which has already been built up with our elder brothers.

Dutch Chemical Industry

Output of the Dutch chemical industry rose by nearly eight per cent in the first 10 months of 1955 compared with the corresponding period of 1954.

A Constant Level Device for Use with Boiling Brine Baths

by DR. M. A. PHILLIPS, F.R.I.C.

THE occasion sometimes occurs when it is necessary to install a boiling water or boiling brine bath (using sodium chloride up to a temperature of about 105°C and calcium chloride up to about 130-140°C); these baths have advantages over oil baths inasmuch as the maximum temperature can be controlled by the concentration of the salt used.

Using the brine baths, this advantage can be lost if the water evaporates as it will, and rapidly, if they are at or near the actual boiling point and, of course, it is very desirable to use them in this way if the original concentration is selected to give a particular temperature needed for a reaction.

Pre-set Level

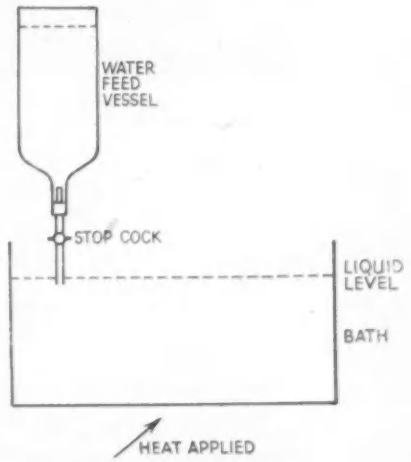
Using a plain water bath, the loss of water can be taken care of by the ordinary type of constant level devices and the simplest of these is a tube set into the bath through the bottom and adjusted to give overflow at a pre-set level; in the case of a water bath, loss of water will not affect the boiling temperature. But loss of water will seriously affect the boiling point of brine baths and here it is essential to maintain the original level by addition of water at very frequent intervals or practically continuously.

We have found, for this purpose, that a 'chicken feed' arrangement as described below is very satisfactory and this device can be used even in places where there may not be a satisfactory water supply; in any case, this automatic and foolproof device has advantages over addition of mains water. Although it might be desirable to add hot water, we have in fact not found this to be at all vital as the heat source can be arranged to compensate for the use of cold water.

For small laboratory brine baths, the feed vessel can be an inverted Winchester quart bottle suitably supported; for larger (pilot plant) work using large scale glass apparatus, the vessel can be an inverted demijohn or carboy. These are filled in the non-inverted position. A bung or cork carrying a glass tube of appropriate diameter (about ¼ in. for Winchester quart bottles and ½ in. for carboys) is then inserted into the neck of the vessel and this glass tube is interrupted by a piece of rubber tubing, clipped up, or a stopcock, closed, can be substituted for this rubber tube/glass tube device.

A metal washer should be fitted over the bung or cork before the glass tube is inserted and the whole device is then firmly wired on to the vessel. With the stopcock closed or the rubber tube clipped up, the whole vessel can be safely inverted and set up over the brine bath without any spillage. The tube is then arranged to be set just below the surface of the boiling liquid and the cock opened or the clip removed.

The mode of operation is obvious; as the liquid level falls on account of evaporation of water, air is allowed to enter the feed vessel which then allows some water to enter the bath to compensate for loss by



Constant level bath (for water, brine or $CaCl_2$) to be used where no water supply is available

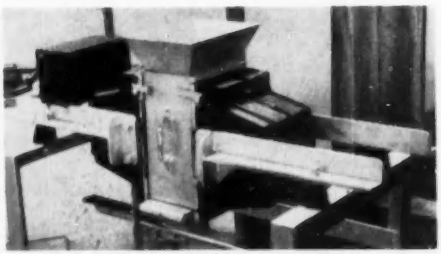
evaporation and when this is done, the water feed stops automatically. This is the principle of the chicken feed used for watering poultry.

It is as well to have a spare feed vessel handy and ready for use when the one in use approaches the end of its feed life.

Magnetic Filter Units

New 'Blencut' Range

BLENDING Machine Co. Ltd., of Bond Street, Hockley, Birmingham 19, has recently designed and produced a range of permanent magnet filter units for extracting finely sub-divided and feebly magnetic contaminating particles from all kinds of powders, liquids, granules etc. The magnetic filters, fitted with grids, are manufactured in a range of four sizes and can be supplied as static units for treating free flowing powders and liquids, or they can be arranged with self-contained vibratory units for dealing with highly viscous liquids or heavy density powders etc.



The Blencut permanent magnet filter unit

The grids are available in different types and sizes to suit the varying characteristics of materials and can be taken apart separately for easy cleaning if found necessary. They are housed in a filter box, the whole of which becomes magnetized when in the magnetic zone created by the magnetic units and become non-magnetic when withdrawn bodily from this field.

Factory Fire

Nearly 40 firemen fought a fire at the works of the International Electrolytic Plant Co. Ltd., at Sandycroft, Chester, on Saturday night, 7 January.

What is BCIRA?

WHAT is BCIRA? is the theme of a booklet published by The British Cast Iron Research Association, Alvechurch, Birmingham. The Association says that its aims are: (1) conducting independent and co-operative research; (2) giving practical advice on individual foundry problems; (3) centralizing and co-ordinating information; (4) assisting in more efficient production and increased productivity of iron castings; (5) helping the industry to meet competition from other materials and processes and (6) enlarging the existing range of applications of cast and malleable cast irons.

The income of the association is derived partly from industry and partly from a Government grant (through DSIR). Every ironfoundry in the country is entitled to full membership and has the right to use all the services of the association. In the case of firms in the UK whose capital is less than half British the application must be approved by the Board of Trade. Approval is usually given. Subscriptions are voluntary and may be treated as business expenses for the purposes of income and profits tax.

There are four main divisions of BCIRA: (1) research department, (2) development department, (3) intelligence department and (4) operational research team. The library of BCIRA is claimed to be probably the most comprehensive service and the largest specialized collection of information relating to the ironfounding industry in the world.

Silicones Exhibition

An exhibition giving details of the history, production and rapidly expanding applications of silicones is to be held in London at the Tea Centre, Lower Regent Street, from 7 to 18 February. Entitled 'Silicones for Industry', the exhibition is to be staged by Midland Silicones Ltd., the first British producer of silicones, and will be open each day from 10 a.m. until 6 p.m. Invitations to the exhibition can be obtained from Midland Silicones Ltd., 19 Upper Brook Street, London W1.

Works Expansion

Triplex (Northern), of St. Helens, Lancashire, manufacturers of safety glass, are planning to double their works area this year.

Progress in Distillation During the Past Year

by D. C. FRESHWATER, Ph.D., A.M.I.Chem.E., & R. A. BETTS, B.Sc.
(Department of Chemical Engineering, Birmingham University)

THE continued interest in distillation is demonstrated by the amount of recent work on distillation and related problems. This review covers the work published in this field from January 1955 up to the end of November 1955.

VAPOUR LIQUID EQUILIBRIA

New data have been reported on the following systems:—

(1) *n*-octane-ethyl benzene at 760, 500, 200 and 50 mm Hg absolute pressure (**1**).
(2) Pentane-benzene at 760 mm Hg absolute pressure (**2**).
Hexane-benzene at 760 mm Hg absolute pressure (**2**).
Heptane-benzene at 760 mm Hg absolute pressure (**2**).
Hexane-toluene at 760, 300 and 150 mm Hg absolute pressure (**2**).
(3) 2-butoxyethanol-alkybenzenes *e.g. o*-xylene, cumene, mesitylene, *p*-cymene, and the butyl benzenes (**3**).
(4) Isobutanol-*n*-butanol (**4**).
Methanol-*n*-butanol (**4**).
Diethyl ether-*n*-butanol (**4**).
(5) methylcyclohexane-toluene furfural at 760 mm Hg absolute pressure (**5**).

Complementary data have been given for the following systems:—

(6) Methylcyclohexane-toluene at 400 and 200 mm Hg absolute pressure (**6**).
(7) Ethylene Oxide in dilute aqueous solutions, 0.7 to 14 mole per cent ethylene oxide at 5°, 10° and 20°C. (**7**).
(8) Ethane-Ethylene-acetylene mixtures containing 20 per cent acetylene (**8**).
(9) Benzene at high temperature and pressures (**9**).

Revised data have been published on the systems:—

(10) Formaldehyde-Methanol-water up to 50 per cent formaldehyde (**10**).
(11) Chloroform-acetic acid azeotrope at 760 mm Hg absolute pressure (**11**).
(12) Chloroform-MEK azeotrope at 760 and 342 mm Hg absolute pressure (**12**).
(13) Furfural-Chloroform (**13**).

An examination of these papers shows that interest is centred upon two problems in particular, the characteristics of mixed base hydrocarbon systems and the behaviour of mixtures of other homologous series such as the alcohols. In general, it is found that the data are internally consistent, that mixed base systems are non-ideal in behaviour and that deviations from ideality are greater if the aromatic is benzene, as might be expected. Polynuclear compounds may behave very differently from those containing a single benzene ring. From a study of systems of alcohols (over the range from their atmospheric boiling points to the maximum temperature and pressure at which liquid and vapour may co-exist) it is found that their behaviour is analogous to systems of hydrocarbon homologues. Note that the three systems investigated were:—

(a) A mixture of homologues.
(b) A mixture of chemical isomers.
(c) A mixture of physical isomers.

The interest in 2-butoxy ethanol is due to its use as an azeotrope former in systems of alkyl benzenes.

Refinements in the prediction of vapour-liquid equilibrium and other data.

Basic data for distillation problems are those relating the vapour composition to the liquid composition and the temperature of equilibrium. Any correlations of these are of assistance in estimating data, when the values for a particular system are unobtainable.

The accuracy of many reported vapour-liquid equilibrium data is questionable because they fail to be thermodynamically consistent. Broughton and Brearly (**14**) propose a method for the adjustment of such data based on the assumption that systematic errors are present due to the design features of the equilibrium still. This was applied to the system methanol-water for two sets of conflicting data, and, after independent adjustment, they agreed.

Thissen (**15**) describes an exact graphical method for the evaluation of vapour-liquid

equilibrium data in a binary mixture from boiling point-composition data. The variation of the activity coefficients with composition is obtained by successive applications of the Gibbs-Duhem equation to a graph relating $\ln(\gamma_1)$ to $\ln(\gamma_2)$ with x as a parameter. Also, the test for internal consistency, due to Harrington, is extended to pressure constant, temperature variable systems and corrected for the non-ideality of the vapour phase. The method is demonstrated on the system methyl cyclohexane and toluene.

Generalized correlations for hydrocarbons giving vapour and liquid activity coefficients as functions of reduced temperature, reduced pressure and boiling point, have been developed by Edminster and Ruby (**16**) from recent data (1945-51), and may be used to estimate values for other hydrocarbons and conditions. They are directly applicable only to paraffin and olefine systems. The use of the boiling point in the correlation allows for varying molecular sizes, while for a different homologous series corrections must be applied. Thus it is possible to evaluate the equilibrium vapour-liquid ratios and so also for the estimation of partial thermodynamic properties.

For similar purposes Canjar *et al.* (**17**) have deduced a correlation for the constants in the Benedict-Webb-Rubin equation of state (which is probably the most accurate equation for the range that it covers (**18**)). It is often necessary to evaluate pressure-volume-temperature data at high temperatures and pressures for hydrocarbons that decompose under such conditions. A correlation for normal paraffins is presented in linear form and satisfies all the available data, allowing the estimation of the thermodynamic properties of compounds higher in the series than hexane—the limit of experimental data at high temperatures. The accuracy of this correlation falls off as the molecular weight increases and so should be used with caution.

A simple yet accurate equation for the activity coefficient (α) in terms of the compressibility coefficient is put forward by Elrod (**19**):—

$$\alpha = \frac{f}{p} = \frac{1}{2 - \frac{pv}{RT}}$$

Grosberg and Mapstone (**20**) present a nomograph for the trial and error solution of vapour equilibria problems for light hydrocarbons so that vaporization and condensation data may be solved by only one trial.

Kharbanda (**21**) gives a short cut procedure for the determination of vapour-liquid equilibria for partially miscible binary systems. In fractional distillation, the problem of calculating the equilibrium conditions between liquid and vapour phases is one that often hinders the designer. He explains how calculations are made, starting from three readily obtained physical variables.

Latent heats of vaporization may be estimated using a nomograph due to Kharbanda (**22**) providing that information is available regarding the critical temperature, critical pressure and the vapour pressure of the substance at the temperature in question. This correlation may not be used below a critical temperature of 0.45°C.

Liquid Viscosities

Two fresh correlations have appeared for the prediction of liquid viscosities. The first, due to Cornelissen and Waterman (**23**), proposes a new equation for representing the viscosity-temperature relationships of liquids. It is claimed to be valid for a wide variety of liquids, associated and non-associated, including sugar solutions, hydrocarbons and mercury. It is generally applicable and is more concise and clear than existing equations. On the systems tested so far the deviation of calculated from experimental results was rarely greater than 1.5 per cent. The second of these correlations is due to Grunberg (**24**) who proposes that an equation using three empirical constants, and therefore requiring experimental data at three different temperatures, be used for the representation of viscosity-temperature data of hydrocarbons. This is because the state of order and configuration of large molecules is altered by changing temperature and the usual exponential type of equation does not fit the data.

Kharbanda (**25**) proposes that the change of thermal conductivity of gases with temperature may be correlated by an equation of the Sutherland type for the viscosity-temperature relationship of gases. Because of the relationship between visco-

sity, specific heat and thermal conductivity, this is to be expected.

A further paper by Kharbanda (**26**) enables the surface tension of liquids to be estimated up to their boiling point from a minimum of experimental data. Nomograms are presented for the direct solution of the problem. Such knowledge is important in distillation because of the effect of surface tension on the size and therefore on the area of droplets. It also affects the hold up in packed columns and the effective slot height of a bubble cap. The equations developed utilize such additive properties as the parachor and refractive index, and so are applicable to liquid mixtures.

In the past the estimation of the temperature drop across a condensing film has been rather inaccurate. Goltz (**27**) proposes a more certain way of doing this.

THEORY & CALCULATIONS

In an attempt at clarification of the vocabulary of unit operations, Klinkenburg (**28**) presents an analysis of such terms as batch, intermittent, continuous, stepwise, co-current, crossflow, multiple contact etc., mainly as applied to mass transfer (diffusional) processes.

Continuous Distillation

A nomograph (**29**) is now available for the rapid solution of distillation columns handling a binary feed. It employs a number of simplifying assumptions and so necessitates a minimum of experimental data.

Acrivos and Amundren (**30**, **31**, **32**, **33**, **34**) have published a series of articles 'On the steady state fractionation of multi-component and complex mixtures in an ideal cascade'. In Part I the equations for the steady state rectification of mixtures which obey a rather general vapour-liquid equilibrium law in an ideal cascade are solved in closed form. From the mathematical stand point the problem has some interesting features. First, it may be linearized, and second, it can be reduced to an eigenvalue problem which is solved using a new transform. This transform may be finite, depending upon the number of components in the mixture. Methods for the numerical evaluation of the formulæ as well as applications to practice, will be reported elsewhere (**30**).

The calculation of minimum reflux ratio is dealt with in Part II, and it has been shown that, for multi-component and complex mixtures in an ideal cascade, this problem may be solved in closed form. The calculation involves the solution of two rather unusual integrals (**31**).

Part III discusses the numerical methods of calculation of the number of stages necessary for the rectification of complex mixtures. The methods are summarized and developed for numerical computation. The formulæ proposed involve the computation of improper integrals for which a method of solution is developed. A numerical example is given and plate by plate calculations are also considered (**32**).

In Part IV, the methods previously considered are extended so as to allow the calculation of NTU's for packed columns for a given separation (**33**).

Formulæ are developed in Part V for complex mixtures which are characterized by continuous or semi-continuous distribution functions. Two numerical examples are considered, one for continuous and the other for semi-continuous mixtures (**34**).

In another paper (**35**) Acrivos and Amundsen have applied the principles of matrix mathematics to multicomponent fractionation problems, including the transient behaviour of some stagewise systems.

Simple Technique

A simple though rigorous technique is described by Edmister (**36**) for the solution of petroleum distillation calculations. Calculations are made for several points on the true boiling point distillation curve of the petroleum fraction and the distribution ratios for these points combined by graphical integration. This procedure is essentially replacing the summation used in calculations for mixtures of a finite number of components, with an integral for mixtures of an indefinite number of components. The principle is illustrated by examples of equilibrium flash vaporization, bubble and dew points and fractional distillation.

On the assumption that the relative volatilities and the molal overflow are constant in a given column section, Eshaya (**37**) develops a comparatively simple and rapid method of performing multicomponent fractionation calculations. The proposed method enables one to calculate, directly, by means of tabulated values of two functions, E_1 and E_2, the liquid composition on the nth plate (x_n) without going through

the calculations for intermediate plates. This is done by the equations:—

$$x_n = x_f E_1 + \frac{x_d (p_r - 1) E_2}{p_r}$$

in rectifying section.

$$x_m = x_w E_1 + \frac{x_w (p_s - 1) E_2}{p_s}$$

in stripping sections.

where:— x_f = composition of a component in the feed, mole fraction.

x_w = composition of a component in the residue, mole fraction.

x_d = composition of a component in the distillate, mole fraction.

p_r = slope of the operating line in the rectifying section.

p_s = slope of the operating line in the stripping section.

and E_1 and E_2 are functions of the equilibrium ratio, reflux ratio and number of plates.

It is believed that this method offers considerable simplification in rectification calculations.

Another simplification is shown by Klein and Hansom (**38**) who combine Underwood's equations to give a solution in the form of a sum of difference products. An example of a five component system is given.

Butler (**39**) presents a precise method for the calculation of the minimum number of plates required for the separation of hydrocarbon mixtures at atmospheric pressure.

Plate Columns

The problem of distillation with a chemical reaction proceeding at the same time is handled by Marek (**40**) for plate columns. He concludes that a knowledge of the factors influencing the course of the reaction makes possible a rational choice of operating conditions and column construction for a specified purpose.

A discussion of columns with side streams (**41**) shows that the separation of a ternary mixture in a single column is now a practical possibility.

Little or no new work appears to have been released on batch distillation processes.

A review of the relevant work on distillation up to the end of 1954 is given by Jones (**42**).

APPARATUS & PERFORMANCE

(a) Plate Type Columns

Kelly *et al.* (**43, 44**) show in detail how to get the best performance from fractionating towers. The first paper deals with precise fractionation and the second with crude distillation.

An extensive series of tests on refinery vacuum flashing equipment is described in a paper by Filak *et al.* (**45**), in which the experimental results are compared with figures calculated by the best known methods. Great care was taken to minimize the experimental error.

Based on a 45 in. diameter tower, Kennedy *et al.* (**46**) show that the number of theoretical plates in a column does not increase proportionally with the number of actual plates in the range from 20 to 40 plates. Thus the overall plate efficiency shows a marked decrease and its use in calculations is questionable.

Four useful additions to the theory and practice of bubble-cap and tray operation have been released. Munk (**47**) presents some simple charts to show the effect of vapour and liquid flows as well as the physical properties of the trays. Trays designed or modified according to these charts show a marked improvement over usual designs. Slot opening is an important dimension for the calculation of pressure drop, entrainment, capacity and efficiency. Winn and Keller (**48**) show a nomographic solution to these otherwise difficult calculations. Garner and Freshwater (**49**) have presented a comprehensive survey of bubble plate hydraulics on a five ft. tray. They cover a wide range of air and water rates and plate efficiency is calculated from the air humidities, using the change in concentration of an inorganic salt to obtain the exit air humidity. The significance of pressure drop and foam quantity is discussed in relation to plate efficiency. The effect of liquid path on plate efficiency is studied by Gautreaux and O'Connel (**50**), who show that the usual correlations for efficiency, in terms of relative volatility and liquid viscosity, break down on trays having a long liquid path, when the experimental efficiency is better than that predicted. As yet no quantitative results can be claimed.

May and Frank (**51**) show that the hydraulic gradient in large diameter

bubble trays may be satisfactorily compensated by 'stepping' the rows of caps at right angles to the liquid flow.

Papers in which the performances of bubble caps and sieve plates are compared agree that in most aspects the sieve plate is superior. Jones and Pyle (**52**) find that for sieve plates, the pressure drop is less, capacity greater and the cost of the same sized trays less than for bubble caps. Also entrainment is only about 20 per cent of that for bubble caps. As, for the same purpose, a smaller sieve plate tower would be necessary, the saving in capital cost is considerable. Kelley *et al.* (**53**) show that the perforated plate is entirely satisfactory in petroleum gas absorption as regards efficiency and capacity and also has good fouling characteristics in fairly clean conditions. They estimate that a single pass perforated plate is as good as an equivalent four pass bubble plate.

Data for perforated plates by Umboltz and Winkle (**54**) show the effect of hole diameter, pressure and vapour rate on the efficiency and pressure drop.

The use of the turbogrid is extending and the Royal Dutch Shell group, who used this type of plate for the first time commercially in 1950, now use it in over 100 columns. Experience gained so far shows that, in crude oil distillation service, its most attractive use is in desuperheating sections and above flash sections, where its self cleaning action and low pressure drop give tray performances better than conventional trays. It is not so suitable for atmospheric or vacuum work where large fluctuations of load are to be expected. In general increases in capacity of up to 60 per cent have been realized by replacing conventional trays by turbogrid trays. Royal Dutch Shell hope to reduce these limitations by future work.

Uniflux Tray

Bowles (**55**) writes of his experience of the Uniflux tray in commercial distillation units of which quite a number are in operation or planned for the near future.

A laboratory sieve plate (**56**) built by Royal Dutch Shell is described for operating variables on plate efficiency. Especial care has been taken of the possibility of measuring and regulating the flow of material and heat to individual trays.

It is now possible to obtain glass bubble cap trays (**57**) with several caps per tray to give smooth operation. The cap and riser are made as one unit and fit, by a ground taper, into the tray.

(*b*) *Packings*

The Spraypak type of packing is becoming popular because of its useful properties, namely, a capacity twice that of conventional packings, HETP of 1.5 to two ft. and substantially independent of tower diameter, flexibility down to 50 per cent of design load, smooth and efficient operation up to the loading point, moderate pressure drop (at the flooding point it is about one inch water per foot of packing height), low hold up, even liquid distribution, low cost and easy installation.

In one example, a tower filled with Spraypak had twice the capacity of a tower of Raschig rings with only half of the packed height for the same duty.

This type of packing was developed at Harwell and is suitable for the separation of water and heavy water by distillation, a process which would be uneconomic when using conventional equipment despite the availability of 'free' (*i.e.* geothermal) steam.

Garner *et al.* (**58**) present a correlation for the prediction of the loading velocity in columns packed with Raschig rings and Berl saddles. The correlation takes the form of a dimensionless equation. Experimental work on the system, methyl cyclohexane-toluene at a liquid to gas ratio of unity showed an error of 2.8 per cent between calculated and experimental results.

MISCELLANEOUS

(*a*) *Entrainment*

A study of the problem of entrainment was carried out by Newitt *et al.* (**59**) using chiefly air and water at various temperatures. They conclude that entrainment is due largely to droplets formed as a bubble collapses, which are of about one mm. diameter. In their experiments they used bubbles of from 0.31 to 0.53 cm. diameter, and they noticed that as the temperature of the system was raised so the height to which the entrainment droplets were projected was decreased. A discussion follows of the problems associated with the removal of entrainment and of the possibility of re-

entrainment occurring from the baffles. Their conclusions are:—

(1) That elimination of large drops is fairly simple, *e.g.* by increasing the volume of the vapour space or by increasing the plate spacing.

(2) That sufficient theory and data now exist to design for the optimum number, size and arrangement of baffles.

(3) That the depth at which a bubble is formed affects the trajectory of the main drop that it forms on bursting.

(4) That if bubbles are generated at very shallow depth there is a marked decrease in the number of large drops.

(b) New Contacting Devices

Helsby and Birt (**60**) describe a method of removing the soluble part of a gas by a foam bed which is formed by a porous plate through which the gaseous phase is discharged into the absorbent liquid phase which flows across it. It is shown that high coefficients of absorption are obtained and that such a plate is superior to any conventional equipment for a specified job. A tube plate may be used instead of a porous plate.

Intense Activity

Dixon and Kiff (**61**) carried out similar experiments but they believe that the high efficiency of the operation is due to a region of intense activity at the surface of the plate, while the rest of the foam bed is about as active as in normal trays. Within its limits of operation there is no doubt that such a device is very much more efficient than the conventional plant. It so happens, however, that the best efficiency occurs at low gas rates.

Difficulty may arise in such equipment owing to channelling of the foam, but it is believed that increased liquor agitation will cure this.

(c) Bubbles

Benzing and Myers (**62**) studied the formation of bubbles at low rates—less than 100 a minute, in the so called 'static' region. Their results could be correlated by a dimensionless equation relating the bubble size to the physical properties of the system, which shows that the gas properties and liquid viscosity are of no importance. Also the frequency of bubble formation has little effect if orifice throat length is negligible, except where the orifice approaches the geometry of a thin plate orifice.

A similar study of the mechanics of bubble formation is presented by Bowers (**63**) who comes to the following conclusions:—

(1) At very low rates of formation the size of a gas bubble produced from an open ended tube immersed in a liquid can be derived by equating its buoyancy and surface tension forces.

(2) Approximate relationships exist for the bubble size produced by single orifices.

(3) The bubble size is independent of gas rate, and depends upon orifice diameter at low rates. The reverse is true at high gas rates.

(4) Bubble size is greatly affected by the liquid properties.

(5) Porous masses may be used to produce small bubbles even at high rates in liquids at low viscosity.

(d) Control in Distillation Units

The control of batch distillation units is discussed by Freshwater (**64**) who considers the types of instruments to be used and their disposition in the equipment. He concludes that progress in this field is limited by a lack of precise knowledge of the variables involved in batch distillation.

In the second of a series of articles Pollard (**65**) discusses the overall problems of plant control with reference to a continuous fractionating column. The article subdivides the overall problem and a more detailed consideration is given to the regulation of the individual streams of the typical fractionating column, whereby the essential variables may be controlled. Examples of four typical completely instrumented systems are also discussed. In general he says that the extent of instrumentation depends upon the rigidity of the product specifications, and that the control characteristics of distillation columns are not good because of the dead time and process capacity.

Control is best established so that each independent variable is controlled by only one primary control, but sufficient flexibility must be allowed for variations in feed and the permissible variations in product quality.

CONCLUSIONS

The field of stagewise calculations appears to retain its popularity with many workers no doubt due to its susceptibility to

mathematical analysis. However, as Gilliland pointed out in 1950 (**66**) these investigations are now in the region of the law of diminishing returns and the major effort should now be on obtaining more vapour-liquid equilibrium data and on the special but important problem of batch distillation. A better appreciation of the latter will lead to a fuller understanding of the problem of transient behaviour in continuous columns. Despite continuous activity in the field of new contacting devices it seems that the bubble cap plate is unlikely to be replaced to a very great extent as yet. Fundamental researches into mass transfer phenomena in distillation continue but progress is rather slow owing to the exceedingly complex nature of the problem and the large number of variables.

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Pipe Problem Solved

AN unusual problem has been solved so successfully by the Flexibles Advisory Service of Compoflex Co. Ltd., 26 Grosvenor Gardens, London SW1, that a repeat order has just been received.

At the Shoreham, Sussex, works of British Portland Cement Manufacturers Ltd., a slurry is brought through an eight inch diameter steel pipe to a large storage tank, and the problem occurred near the end of the run where site conditions necessitated a bend in the pipe. The abrasive action of the slurry wore through the steel wall at this point in approximately five months.

The Compoflex solution was an eight inch ID cured rubber hose, fitted with flanges, installed at the trouble point. The cushioning effect of the flexible rubber hose prevents penetration so successfully that the hose has now been in constant service for over 18 months without showing undue signs of wear.

The hose has an anti-abrasive synthetic rubber lining, ¼-inch thick; eight plies of canvas reinforcement and a rubber outer cover.

New Scrubber & Absorber

Addition to Turner & Brown's Range

TURNER & BROWN LTD., chemical plant engineers, Bolton, manufacturers of a range of pvc centrifugal fans, have now produced a fume scrubbing and absorption tower claimed to be 100 per cent efficient in the scrubbing of air saturated with sulphuric and hydrochloric acid, and 99.9 per cent efficient with nitric acid.

The Turbro fume scrubbing and absorption tower has been specially designed for the elimination of sulphuric, hydrochloric or nitric acid fumes discharged in considerable quantities from various chemical and industrial processes.

The S/1 unit is capable of scrubbing fumes from 14-20 litres of evaporated acid per hour; larger towers are in course of construction for many varied fume scrubbing requirements.

The Turbro tower and internal components are constructed entirely from B. X. Cobex rigid vinyl sheet, and is therefore unaffected by the strongest of acids. The tower can be supplied with a special fume cabinet, or alternatively as a single unit for incorporation into existing equipment. It is approximately eight ft. high by two ft. square.

The complete removal of the gases is carried out in three stages. The first is by absorption of greater part of the gases in liquid, after which suspended globules of moisture are eliminated in a special eliminator section; finally, any small traces of gases left after these two processes are completely neutralized by a chemical reagent contained in a tray.

The chemical reagent tray is easily removed from the tower for re-charging. This is necessary every 10-14 days, depending upon the amount of fume being scrubbed.

Metal Hydride Formation

FORMATION of solid solutions or metal hydrides as the mechanism of hydrogen entry into metals during pickling or plating was proposed by Dr. L. D. McGraw of Battelle Institute, Columbus, Ohio, at the recent annual meeting of the Electrochemical Society of America in Pittsburgh.

Discussing his hypothesis in a paper he presented at the meeting, Dr. McGraw said he considered solid solution or metal hydride formation to be a more likely mechanism of hydrogen entry than the adsorption of atomic hydrogen or the formation of molecular hydrogen in metal. The entry mechanism proposed did not require that entry occurred at specific rifts or lattice defects in metals; entry might occur at any point.

Dr. McGraw said that in his research at Battelle, which was sponsored by the National Advisory Committee for Aeronautics, he had noted that the rate of hydrogen accumulation in metals during plating or pickling processes depended on the combination of rates of entry, diffusion, and exit of hydrogen. If oxidizing agents were present, hydrogen exit was speeded and less embrittlement occurred. On the other hand, such impurities as chlorinated hydrocarbons and arsenic reduced the exit rate and resulted in more embrittlement.

Cellulube Series Expanded

THE chemical division of Celanese Corp. of America has expanded its cellulube series of fire-resistant synthetic oils to include hydraulic fluids and lubricants in six controlled viscosities. These fluids, which Celanese describes as straight phosphate esters, are now available in viscosity ranges of 90, 150, 220, 300, 500 and 1,000 SUS seconds at 100°F.

The addition of these viscosity ranges has broadened the use potential for Cellulubes in industries where fire-resistance in functional fluids is a significant safety factor, claims Mr. R. W. KixMiller, the vice-president and general manager of the chemical division of Celanese. Cellulubes are finding use, as replacements for flammable petroleum oil products, in die-casting, metal-forming and allied industries etc.

A new Celanese chemical plant at Point Pleasant, West Virginia, will start large-scale production soon.

Leather Science During 1955

by A. HARVEY, F.R.I.C.

THE high-light during 1955 in the realm of leather trade science was, without doubt, the International Conference of Leather Chemists held in Stockholm from 1 to 4 August, organized by the Nordic Leather Chemists' Society under the aegis of the International Union of Leather Chemists' Societies.

The latter organization replaces the former International Society of Leather Trades' Chemists which was dissolved in 1947 to make way for a more effective means of bringing together leather chemists throughout the world. The result is that the major leather chemists' societies are now members of the International Union, and it is doubtful whether any other branch of applied chemistry is so intimately organized on a world-wide basis. This enables close collaboration in subjects of common interest, and brings about scientific and social contacts which are invaluable for progress.

This was clearly seen at the Stockholm Conference (the Fourth Biennial) when over 280 delegates from 25 countries met to discuss a variety of topics. Dr. R. G. Mitton, Dr. E. Baumann, Dr. J. R. Kanagy and Professor P. Chambard contributed papers on the physical properties of leather, while Dr. K. G. A. Pankhurst described work on vegetable tanning as revealed by mono-layer studies, a field he has made particularly his own.

Vegetable Tannage

This was supplemented by a paper on the chemical aspects of vegetable tannage by Dr. T. White and one by Dr. G. Otto on the nature of the reactions taking place between collagen and the various materials which are used in the tanning processes. Dr. A. Küntzel dealt particularly with synthetic tannins, a subject carried a little further by Prof. P. Chambard on the application of methylol-urea resins. This by no means exhausts the topics dealt with, but does indicate the wide field for investigation to those interested in leather technology (*Leather T. Rev.*, 1955, 17 & 31 August).

Going further afield for a moment, the great activity in leather chemistry in India is worthy of comment. A year or two ago the Central Leather Research Institute was opened in Madras under the able leadership of Sri B. M. Das, a well-known figure in England and throughout the world. Technical education and a mild form of research have been going on in India for some time, but it was felt that greater efforts should be made for improvements in these directions

Valuable Indian Research

A splendidly equipped institute has been established, and research of immediate value to the Indian leather industry is being pursued with vigour. In this connection they have an able assistant director in the person of Dr. Y. Nayudamma, a past student of Northampton Technical College and Lehigh University. Simultaneously, a Leather Technologists' Association of India has been formed, which publishes its own official journal, and which acts as an excellent medium for the publication of research work carried out at the Institute. The Indian leather trade should greatly benefit by these excellent progressive moves.

At home, an event of significance and of particular importance from the educational standpoint was the official opening of extensions to the National Leathersellers College, London, by The Rt. Hon. Sir David Eccles, Minister of Education, on 15 November. Since its foundation in 1909 the College has played a major role in the technical training of entrants into the leather industry, and many of its past students have held, and still hold, key positions in this important trade. Development, however, has been somewhat handicapped by its limited accommodation and, in order to expand its usefulness as a National College, extensions were decided upon in 1952.

These now include additional teaching and research laboratories, a second lecture theatre, and greatly enlarged practical workshops and tanyard, fitted with the latest types of machinery and plant. In addition to scientific and practical training of the first order, the College will be able to give more attention to such ancillary subjects as cost accounting, engineering and commercial training including industrial relationship.

A very successful annual meeting and conference of the Society of Leather Trades' Chemists was held in Leeds University on 23-24 September under the chairmanship of its president, Dr. R. G. Mitton. In his presidential address he made special reference to official methods of analysis and indicated that the Society's analytical sub-committees were revising these methods, bearing in mind those being considered by the joint services committee and the BSI. This is a work of considerable importance. Incidentally, at this meeting, it was announced that the Donald Burton Prize for 1955 had been awarded to S. R. Evelyn of the South African section of the Society, and this prize was presented to him at the section's annual convention in Port Elizabeth on 12-15 October.

Steady Flow of Work

During the past year no startling discoveries can be said to have been announced in this particular branch of applied chemistry, but there have been a number of published papers which indicate a steady flow of valuable work from both fundamental and technical viewpoints.

Starting with hide preservation, Beakbane and Mitton (*J.S.L.T.C.*, 1955, **39**, 138) suggest that E. African hides should be dipped in a saturated solution of sodium silicofluoride before suspension drying.

Another form of hide, or rather pelt, preservation, *i.e.* pickling, used for the purpose of storage during transit etc., has been further considered by Bowes and Mitton (*J.S.L.T.C.*, 1955, **39**, 36). It is pointed out that there is always some deterioration with the acid and salt pickle, and hence the need for careful control particularly as regards temperature. If temperatures in the range of 30°C are contemplated, acid must be kept at a minimum with a high salt concentration. The soluble nitrogen content of the pelt is looked upon as a good guide to the extent of hide substance deterioration.

Although not so widely used as formerly, dewooling by sweating is still employed in some cases, as it gives a damage-free wool. Much work has been done on this subject in Australia and it has also been investigated by the BLMRA in England. Green (*J.S.L.T.C.*, 1955, **39**, 20) finds that a species of *Pseudomonas* is largely responsible for loosening the wool. *Nematodes* assist by equalizing the distribution of bacteria in the skin, but do not themselves attack pelt.

A survey of all possibly useful indigenous vegetable tanning materials still continues in India, no doubt with the idea of curtailing imports from elsewhere. Goran bark (*Ceriops roxburghiana*, Arn.) has been tested by Khalique and Ahmed (*J.S.L.T.C.*, 1955, **39**, 150) and more fully by Burton and Barat (*ibid.*, 183) who have also looked into the possibilities of Avaram and Konnam barks.

Although not strictly a vegetable tanning material, considerable quantities of sulphite cellulose extract (wood pulp extract) are used in the industry, and its purification for this purpose has reached a high state of perfection. Some investigations have been carried out in the US with a view to further enhancing its value. Marshall and Wilson, with others, have condensed decalcified sulphite cellulose extract with cresol to produce a material for the retanning of chrome leather (*J.A.L.C.A.*, 1955, **50**, 85) while later work shows that a mixture of quebracho extract and a phenol-lignosulphonic condensate has possibilities for the tannage of heavy sole leather.

Black Wattle Bark Extract

Extensive studies on the constituents of black wattle bark extract have been undertaken in South Africa at the Leather Industries Research Institute by Roux. He first shows (*J.S.L.T.C.*, 1955, **39**, 80) that there is a marked parallelism between the affinity of polyphenols for collagen and for cellulose in water, which makes paper chromatography a useful research tool in studying the relative affinities of black wattle polyphenols or collagen. Later (*ibid.*, 153) he follows the oxidative changes undergone by D-catechin solutions in air, and confirms some earlier findings of Wilson and Kern, of the condensation of non-tannins into tannins during the concentration of non-tannins as in tannin analysis. The third paper in the series (*ibid.*, 321) considers the reaction between the polyphenols of wattle extract and sodium bisulphite and shows the preferential reaction between the more astringent tannins.

Synthetic tanning products continue to be an interesting field and, apart from patents, Rosenbusch (*Das Leder*, 1955, **6**, 58) describes the preparation of amphoteric syntans

by the condensation of polyphenols, aromatic amines and formaldehyde.

Filling materials stated to have some special attributes have been the subject of a few publications. Küntzel and Quendt, (*Das Leder*, 1955, **6**, 73) suggest that the condensation product of dicyandiamide and formaldehyde can be precipitated into chrome leather by drumming to give filling effects. Oehler, Davis and Kinmonth have described a pilot plant test on the impregnation of vegetable sole leather with polyisobutylene and other polymers (*J.A.L.C.A.*, 1955, **50**, 16). A solution of polyisobutylene is used, which, after removal of the solvent, results in a deposition of about 17 per cent of solids which, it is claimed, increases the wearing life of the leather by about 80 per cent.

Leather deterioration in use is a subject under constant survey, and interesting work appears from time to time. For instance, the stability of chrome leather against mould growth is shown in a report by Mitton and Turner (*J.S.L.T.C.*, 1955, **39**, 343). Mould growth causes little change in the physical properties of this particular leather, and the tensile strength is unaffected. Changes which do take place are associated with the oils and fats in the leather rather than with the leather fibres. On the other hand Roddy and Lollar (*J.A.L.C.A.*, 1955, **50**, 180) examined some deteriorated white chrome leather uppers and found that damage was caused by the hydroxy acid constituents of perspiration, which strip the chromium from the fibre, leaving the latter unprotected. Gustavson (*ibid.*, 414) agrees with this and also points out that urea, another component of perspiration, is very destructive towards vegetable leather and particularly vegetable insole leather.

Physical Assessment

The assessment of leather through its physical properties has attracted much attention, and during the past year several papers of importance have appeared. Kanagy (*J.A.L.C.A.*, 1955, **50**, 112) thinks that the tongue tear and bursting strength tests are better for judging upper leathers than the tensile strength.

Measurements of the integral and differential heats of wetting of chrome and vegetable leathers and the integral heat of wetting of hide powder have been made by Mitton and Mawhinney (*J.S.L.T.C.*, 1955, **39**, 206). Mitton has also determined the coefficient of linear expansion of leathers (*J.S.L.T.C.*, 1955, **39**, 276) and obtained the values of 27, 30 and 29 $\times$ 10^{-6} per °C for strips of dry chrome, semi-chrome and vegetable leathers respectively. Damp vegetable leather is about 50 per cent higher than for dry, but the values for other leathers when wet are practically unaltered. Hence the heating of damp footwear of vegetable leathers can bring about marked dimensional changes. Another matter of importance in foot comfort and leather clothing generally is that of diffusion of water vapour. Mitton (*ibid.*, 385) shows that the diffusion of water vapour in leather is also wholly via the capillary spaces and very little indeed through the solid fibres.

Leather Gripping Properties

Road safety seems to have been at the back of the work by Tancous (*J.A.L.C.A.*, 1955, **50**, 274) who determined the coefficient of friction of gloving materials against a specially devised car driving wheel. He finds that leather gloves have gripping properties approaching those of the bare hands, whereas wool and fabric gloves were very much below. Hence leather is the preferred material for driving gloves.

The mechanism and other aspects of chrome tanning has brought out several papers of interest. Gustavson (*J.S.L.T.C.*, 1955, **39**, 2) considers the combination of non-cationic complexes with collagen. Also, using normal and esterified collagen and cationic chromium sulphate, Sykes (*ibid.*, 56) suggests that combination takes place through the COOH groups of the collagen to give heat stability to the leather, while the other reaction involving the OH groups is of lesser importance and does not contribute to heat stability.

A short note by de Wijs (*ibid.*, 381) demonstrates that the ionic acid in the chrome complex enters the complex when unneutralized leather is dried, but by neutralizing the leather, the ionic acid of the complex is removed. The olation of chrome compounds was discussed by Shuttleworth (*ibid.*, 133) which brought a reply from Küntzel (*ibid.*, 359) in which he pleads for adherence to the conception of olation as distinct from basicity as originally expounded by Stiasny and for adherence to the original nomenclature.

There have been relatively few published papers on analytical topics during the year. The nature of the acid groups in chrome leather has been investigated by Rao (*J.S.L.T.C.*, 1955, **39**, 217) who favours the pyridine extraction method for the removal and determination of ionic acid groups, the complex bound acid being retained in the leather. The latter is determined as the difference between the total sulphate and that removed by pyridine.

Burton and Ma described two new methods for determining acid in vegetable tanned leather (*J.S.L.T.C.*, 1955, **39**, 286). One consists of extracting the free acid with pure methyl alcohol, and the second is based on the extraction of the acid with a glycol isopropyl alcohol mixture containing sodium acetate.

In the examination of vegetable tanning extracts, copper is usually determined by the official method of the SLTC which involves ashing a considerable quantity of the material and isolating the copper electrolytically. The sub-committee appointed to consider the matter now proposes the adoption of the colorimetric method using sodium diethyldithiocarbamate, with interfering ions suitably sequestered as first proposed by Hoare (*Analyst*, 1937, **62**, 657).

The fastness properties of dyestuffs on leather are a problem which has received little attention hitherto as compared with the same problem in the textile industry, but the importance of the matter was emphasized by Russell and Mullen in a paper given in Manchester, and assumes a rather different aspect (*J.S.L.T.C.*, 1955, **39**, 70). They say that fastness of the dye alone (*e.g.* fastness to light) is not the sole consideration, and due thought must be given to the substrate (the leather itself), as well as the processes involved in leather finishing. The problem is now to be considered by a sub-committee set up by the SLTC, and some aspects are also to be investigated by an international commission. The subject bristles with difficult points, but is most important from the industrial point of view.

Polythene Ointment Base

A NEW ointment base which employs a form of polythene is being used in a number of ointment products manufactured by E. R. Squibbs & Sons Division, Olin Mathieson Chemical Corporation, 460 Park Avenue, New York 22, NY.

The new base is available in two forms, Plastibase and Plastibase hydrophilic. Plastibase is non-water-absorbing and contains 95 per cent liquid petrolatum USP and five per cent polythene. Plastibase hydrophilic can absorb up to 10 times its weight of water and is made up of 88.16 per cent liquid petrolatum USP, 5.64 per cent polythene, six per cent emulsifying agent, 0.1 per cent antioxidant and 0.1 per cent preservatives to prevent mould growth after the addition of water.

Tests made on ointments containing salicylic acid have shown that when plastibase is used as a base the release of active material is both more rapid and more uniform. It has also been shown that increases in temperature do not cause settling out of the drug particles.

Easy 'spreadability' is also claimed for ointments containing Plastibase as base material—an important point when the skin is sore and sensitive. The softness of the base is not appreciably increased by the addition of large amounts (up to 20 per cent) of solids such as zinc oxide.

Nothing New as a Name

PLUTONIUM as a name, if not as an element, is older than most people suppose. It is to be found in the index to Volume VI of *The New Monthly Magazine and Universal Register*, 1816. The reference reads:

'Dr. Clark of Cambridge has given the name of plutonium to the new metal which he has obtained by mixing barytes in the pure state with lamp oil and then exposing it to the heat of an ignited gaseous mixture of the constituents of water; two parts of hydrogen gas by bulk being mixed with one part of oxygen gas.'

Dr. Clark's product was probably barium sulphide; it certainly was not element number 94.

Aluminium Output Reduced

A shortage of hydro-electric power caused by the dry summer reduced Norway's aluminium output last year to 70,000 tons, 25,000 tons below maximum.

Vinyl Resin Emulsions & Their Monomers

Some Topical Aspects, Practical & Theoretical

by H. WARSON, B.Sc., F.R.I.C.
(Research Manager, Vinyl Products Ltd., Carshalton, Surrey)

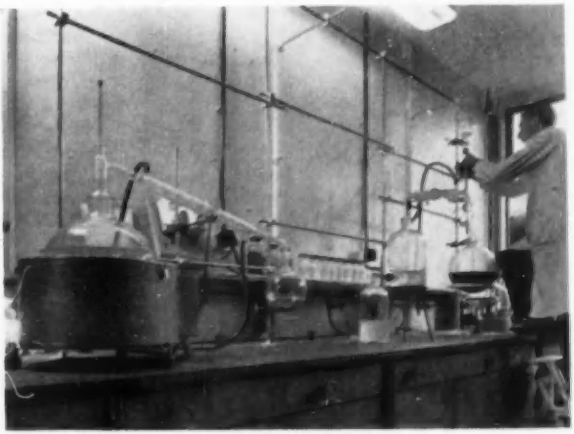
THIS article is principally concerned with the chemistry and uses of polymers in emulsion form, and in particular polyvinyl acetate. Some recent allied developments are also included, but reference to dienes and synthetic rubbers is omitted.

Vinyl resins may be defined as those which are produced by polymerization of an unsaturated compound (a monomer), without the elimination of any simple compound such as water. The simplest compound is ethylene $CH_2:CH_2$, which is not the easiest material to polymerize, but which forms the well known polythene under special conditions. The derivatives of ethylene, especially the unsymmetrical ones, are much easier to polymerize.

These include styrene ($C_6H_5.CH:CH_2$), vinyl chloride ($CH_2:CHCl$), vinylidene chloride ($CH_2:CCl_2$), acrylonitrile ($CH_2:CHCN$), esters of acrylic acid ($CH_2:CH.COOH$), and methacrylic acid ($CH_2:C(CH_3).COOH$), and vinyl esters, of which by far the most important is vinyl acetate ($CH_2:CH.COOCH_3$). A copolymer may be defined as a resin formed by the mutual polymerization of two or more monomers so that the resulting high polymer consists of units of all the monomers taking part in its formation.

Polymerization is effected by means of a catalyst or initiator. The principal type of catalyst is effective by means of the production of free radicals. A full discussion is beyond the scope of this paper, but is fully discussed in standard works (**1, 2, 3**). In practice, monomers are polymerized under a number of different conditions. These include polymerization in bulk, solution, and in aqueous medium. Solution polymerization may be divided into two classes. In some cases the polymer is soluble in the solvent as when styrene is polymerized in benzene, but in other cases the polymer is insoluble in the solvent and would be precipitated out as when styrene is polymerized in methanol.

Polymerization in an aqueous medium may be achieved by dispersing the monomer in water with a very small quantity of a colloid, with vigorous stirring. During the polymerization process the colloid prevents the polymer from coagulating, and the final product is obtained as fine beads or as a powder, either of which can be readily filtered. Emulsion polymerization involves



A section of the research laboratories of Vinyl Products Ltd.

the formation of a stabilized latex by the use of suitable colloids and emulsifying agents in quantities considerably greater than that used for dispersion polymerization.

The monomer is often pre-emulsified but this is not invariably the case as in some instances the polymer latex is actually more stable than the monomeric emulsion. The final product is in the form of fine particles in an aqueous phase which may vary from 0.1 to about five microns in diameter, and usually a solids content of between 25 per cent and about 65 per cent. Viscosity of emulsions may vary, and an emulsion of high solid content need not necessarily have a high viscosity.

Use of Water

The use of water as a medium for resins has many obvious advantages. It is, of course, very cheap, and there are no problems of inflammability or toxicity against which it is necessary to take precautions. The early work on the preparation of synthetic rubber latices led naturally to corresponding research with vinyl resins, which resemble synthetic rubbers chemically. The earliest work is reported about 1910-15 (for summary see Hohenstein & Mark (**4**)) but it is about 1927 that emulsion polymerization, essentially in its modern form, was disclosed in a number of patents. These indicated the use of a soap or other emulsifying agent, often together with a colloid, and a catalyst or initiator of polymerization, which was usually a peroxide, soluble either in monomer or water.

Since that time development has been reported mainly in a series of patents, but a considerable number of theoretical papers which have attempted to elucidate the mechanism of polymerization in emulsion, have also been published.

One of the major raw materials in the preparation of vinyl monomers is acetylene. Thus, vinyl acetate is produced by the reaction of acetylene and acetic acid.

$$CH_3.COOH + CH:CH = CH_3.COOCH:CH$$

Similarly, vinyl chloride can be produced by the action of acetylene on hydrogen chloride, and during the 1939-45 war vinyl ethers were prepared in Germany by the reactions of alcohols with acetylene.

There has been a considerable lag in the development of indigenous vinyl acetate. Recently, however, several plants have either been opened or announced as under construction. The first of these was the plant operated by the British Oxygen Co. This is situated at Chester-le-Street, Co. Durham, and has been in operation for about a year (**5**).

Two other plants for the manufacture of monomeric vinyl acetate have also been announced. Hedon Chemicals Ltd., which is owned jointly by The Distillers Co. Ltd. and Shawinigan Chemicals Ltd. of Montreal, are to manufacture vinyl acetate monomer at a new plant under construction at Salt End, Hull.

On the other hand, the plant which is under construction at the Spondon Works of British Celanese Ltd. utilizes acetaldehyde and acetic anhydride as raw materials. Both of these chemicals are already in production in adjacent plants and the process may be based on BP 576,397 which describes the catalytic decomposition of ethylidene di-acetate into vinyl acetate and acetic acid with an aromatic sulphonic acid as catalyst, the ethylidene di-acetate being formed presumably by direct addition of acetaldehyde to acetic anhydride. The two reactions may be represented:—

(1) $CH_3.CHO + Ac_2O = CH_3CH(OAc)_2$

(2) $CH_3CH(OAc)_2 = CH_2:CHO\ Ac + AcOH$

Vinyl stearate, which is prepared directly from acetylene and stearic acids, is available from Air Reduction Chemical Co. in the US, and production of vinyl stearate is being stepped up very considerably. The Hercules Powder Co. (**6**) describes vinyl esters of hydrogenated and dehydrogenated rosin and Reid, Codding & Bovey (**7**) describe the preparation of vinyl esters of perfluoro acids by direct reaction with acetylene, but it is not clear whether these are available on an industrial scale.

Synthetic Rubbers

Styrene, an important starting point for many polymers and also synthetic rubbers, is prepared by reaction of ethylene and benzene to form ethyl benzene, which is then dehydrogenated at high temperature to give styrene.

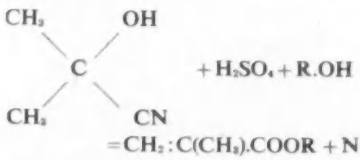
$$C_6H_5.CH_2.CH_3 = H_2 + C_6H_5.CH:CH_2$$

For further details see monographs by Boundy & Boyer and by Gibello (**2**).

Styrene is being produced at the Grangemouth plant of Forth Chemicals Ltd., and it is planned to double existing production.

Methacrylates are manufactured by first condensing acetone with hydrocyanic acid

to form the cyanhydrin, which is reacted with an alcohol in the presence of sulphuric acid.



$$CH_2=C(CH_3).COOR + NH_4HSO_4.$$

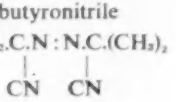
In addition to the commercial methyl, butyl and β-ethoxy ethyl methacrylate, ICI now produce ethyl, nonyl (*i.e.* 3.5.5 trimethyl-hexyl), dodecyl, isobutyl and palm kernel methacrylates in limited quantities.

Acrylates are not in general manufactured in this country, and the development of the Reppe process seems to have made slow progress. The process involves the direct reaction of acetylene with carbon monoxide and an alcohol using a suitable nickel compound as catalyst.

The redox principle of polymerization has now become well established. In brief, it may be described as the use of certain reducing agents together with peroxide catalysts to give greatly accelerated rates of polymerization. This work seems to have been discovered independently in British, German and United States laboratories. One of the classic papers is by R. G. Bacon (**8**). Thus, potassium persulphate used in conjunction with sodium bisulphite is a very efficient redox system. If acrylonitrile is used as monomer, investigation of the system is simplified since the polymer is quite insoluble in water although monomeric acrylonitrile has an appreciable solubility (about seven per cent).

Redox polymerization is used frequently in theoretical investigations, and is quoted in many patents, including those dealing with synthetic rubbers (**1**). In normal practice, however, it is probable that the practical use of redox systems is still restricted since such a system adds another water soluble material to an emulsion, and this decreases the water resistance of the dried film. When the polymer is required in a solid form, the emulsion may be precipitated and the polymer washed. In this case these objections are not so serious.

Azo bis di-isobutyronitrile



decomposes into two radicals $(CH_3)_2.C\cdot$ (CN) and into molecular nitrogen N_2. The free radicals induce vinyl polymerization, and hence this and similar compounds have been used by many recent investigators into the mechanism of addition polymerization since the decomposition into radicals is free from side reactions. Extensive theoretical studies have been made with this initiator (**3**). There are also a considerable number of patents (**9**) covering its use and that of allied products.

Certain other azo compounds such as the diazo thioethers can also be used as initiators of polymerization and also in redox mixes. Most of the work in the US has been on GR-S recipes rather than simple vinyl monomers.

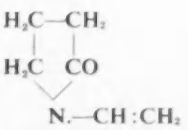
It has been known for a considerable period that tertiary amines can accelerate the polymerization of monomers, *e.g.* an early French patent (**10**) describes the block polymerization of methyl methacrylate with benzoyl peroxide and with dimethyl aniline.

A view of part of the works of Vinyl Products Ltd.

Lal and Green (**11**) have examined a series of amines in which it was found that aliphatic amines and aniline inhibit polymerization, but that a variety of aromatic tertiary amines are effective accelerators of the polymerization of methyl methacrylate with benzoyl peroxide. The same authors have reported that methyl methacrylate can be polymerized by a mixture of N-dimethyl aniline and *o*-benzoic sulphimide (saccharine) (**11**). Similarly Imoto and Takemoto (**12**) have investigated the effect of various substituted benzoyl peroxides with dimethylaniline on the rate of polymerization of acrylonitrile. As might be expected, the presence of nitro-groups slows down polymerization.

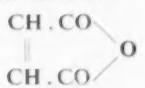
The most technically important resins formed by direct vinyl polymerization are polyvinyl chloride, polyvinyl acetate, polyacrylonitrile, polyacrylate and polymethacrylate esters. All these resins can be prepared by emulsion techniques. Water soluble salts of polymethacrylic acid are also in production.

In addition, polymers of N-vinyl pyrrolidone,



are manufactured by British Oxygen Chemicals Ltd., a range of varying molecular weights being now available. Polyvinyl pyrrolidone was used as a synthetic blood plasma during the war.

Certain ethylenic derivatives which do not polymerize readily themselves, form copolymers with other monomers. The principal compounds in this class are

maleic anhydride 

and the esters of maleic acid $(:CH.COOH)_2$.

These compounds have the property of forming polymers in which the two different units tend to alternate, over a wide range of concentrations, of the initial mix. The copolymer of styrene and maleic anhydride is a well-known example of this type.

In some cases, important resins are formed from other polymers by secondary reactions. The most useful of these is polyvinyl alcohol $(—CH_2.CHOH.CH_2.CHOH—)_n$ which is always formed by hydrolysis of polyvinyl acetate. All attempts to synthesize monomeric vinyl alcohol have so far only led to the formation of isomeric acetaldehyde $CH_3.CHO$.

Some new esters have been prepared directly from polyvinyl alcohol. These include the reaction with a cinnamyl acid halide (**13**). Some very interesting work by E. W. Eckey (**14**) describes the ester interchange of polyvinyl acetate. A catalyst such as sodium hydride is used, and mixtures of acetates such as triacetin or methoxyethyl acetate and methyl acetates are used as solvents. In a typical example the methyl esters of linseed oil are reacted to form a polyvinyl ester of linseed oil, which can be used as a drying oil.

Polyvinyl Acetals

An interesting class of derivatives formed from polyvinyl alcohol by reaction with aldehydes is the polyvinyl acetals. Polyvinyl butyral, which is a component of safety glass and of wash primers, and polyvinyl formal are the most interesting resins of this type. It has been announced by one organization (Vinyl Products Ltd.) that pilot plant quantities of polyvinyl butyral, suitable for use in wash primers, will be available in 1956. All supplies of polyvinyl butyral have so far had to be imported.

Wash primers are used in a new type of metal pre-treatment, which in addition to providing an excellent adhesive bond for subsequent paint films, provides an anti-corrosive film of thickness 0.1-0.3 mils, supplementing the normal anti-corrosive primers.

A typical wash primer consists of two components which are added together at the time of application. One of these, known as the basic grind, is composed of a butyral resin, a basic zinc chromate pigment, and a solvent mix which must contain a primary or secondary alcohol. Isopropanol with some butanol is frequently used. The second phase, the acid diluent, consists of an alcoholic solution of phosphoric acid with a small quantity of water.

The pigmented mix should be thoroughly ground, avoiding steel mills. The final solids content is quite low, about 20 per cent, and on application, which can be by conventional methods such as brushing, spraying, dipping or roller coating, the primer can penetrate into cavitation pits on a metal surface.

Application can be made to many metal surfaces such as steel, zinc, cadmium, tin and aluminium and aluminium alloys. The wash primer can be used for about eight hours after mixing, but will not give good results over grease, mill scale or corrosion products.

Modifications are also possible, such as the use of chromic acid solutions instead of zinc chromate.

The reaction which takes place is a highly complex one. Rosenbloom (**15**) considers that oxidation, probably of the alcoholic solvent, plays a prominent part, and is caused by part of the chromate pigment being soluble in alcoholic phosphoric acid. Some form of complex is probably formed between the butyral resin and the reduced chromate pigment, but only under the influence of phosphoric acid.

Graft copolymers are made by attaching side chains of one polymer to a backbone which may be the same but is usually different. The reaction is essentially one of chain transfer and can best be obtained by activating a polymer so as to form a polymeric peroxide which itself can automatically produce free radicals. The addition of another monomer then produces graft copolymers, although a homopolymer may be formed at the same time.

By this method it is possible to add vinyl acetate chains on to polystyrene. R. A. Hayes (**16**) describes some simple experiments and shows that the addition of dodecyl mercaptan sharply reduces the efficiency of the chain transfer mechanism. This is hardly surprising since this mercaptan is used in normal polymerization as a chain transfer agent to reduce molecular weight.

Simple Experiments

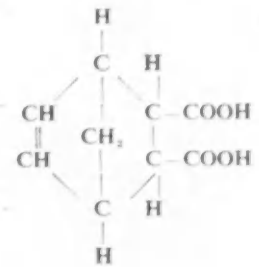
Block copolymers are formed by making linear chains first of one composition, then of another. Melville and Norrish and their schools have done much research on the subject in this country as has Smets in Belgium (**17**), but a detailed account is rather beyond the scope of this review. Melville has published a detailed review in an Italian journal (**18**). It is interesting to note that in order to study the introduction of side chains into polymers, vinyl acetate has been grafted in the presence of C^{14}—labelled polyvinyl acetate (**19**).

A considerable number of patents continue to appear describing improvements in the preparation of synthetic resin emulsions. The 'classical' method of preparing polymerizable emulsions of vinyl esters is the use of a partially hydrolysed polyvinyl acetate (**20**). Not only have a very wide range of emulsifying agents now been claimed, but also the conditions of polymerization have been profoundly modified. By gradual addition of the vinyl acetate to the polymerizing mixture, Shawinigan Chemicals Ltd. (**21**) claim that a much more stable emulsion is obtained with finer particle size and this is especially suitable for the preparation of emulsion paints.

The omission of polyvinyl alcohols is desirable where boric acid and its salts are to be added in any form since polyvinyl alcohol gels with these materials, and an emulsion would be precipitated under these conditions. Vinyl Products (**22**) have described a process in which sodium polymethacrylate and its copolymers are used as polyelectrolyte stabilizing agents together with the sodium salt of an unsaturated acid. In addition major improvements have been made in resin emulsions based on polyvinyl alcohol due to careful control of the latter. These include the Vinamul N.9800 and N.8800 series of Vinyl Products Ltd.

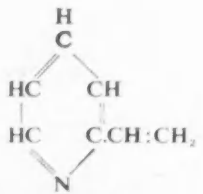
The process of polymerization while gradually adding monomer has been extended to acrylates by the Dunlop Rubber Co. (**23**), using, *inter alia* partially hydrolysed polyvinyl acetate as a stabilizing agent.

An unusual emulsifying agent has been described by H. M. Hutchinson and The Distillers Co. (**24**). The salt of a monoalkyl ester of 3:6 endomethylene tetrahydrophthalic acid is used as a stabilizer for the emulsion polymerization of styrene at a *p*H above three. This emulsifier is formed by the Diels-Alder condensation of cyclopentadiene and maleic anhydride.

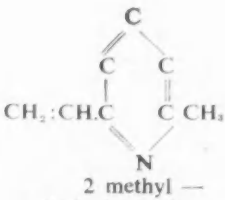


H

Polyelectrolytes are now being increasingly used technically and the Phillips Petroleum Co. (**25, 26, 27**) describes the preparation of poly 2-vinyl and 2-methyl 5-vinyl pyridine by a conventional persulphate polymerization to give a latex which is coagulated by first adding sulphuric acid to give a viscous aqueous solution of the polymer, which is then precipitated by a base, and washed thoroughly to remove all traces of soap. The polymer is dissolved in isopropanol and purified by reprecipitation with water. It is found to be a very efficient emulsifying agent when used in the form of its salt for producing latices of polystyrene etc. These are presumably cationic in charge (see below).



2-vinyl pyridine



2 methyl — 5 vinyl pyridine

The use of a water insoluble polymer which is available in powder form, but which dissolves in ammonia to form an emulsion, has always attracted considerable interest. Such a product would become resistant to water on drying. A re-emulsifying powder of this type known as Emu 120FD, is marketed in Germany. It is probably a copolymer of styrene with an acidic anhydride.

It is unfortunately not readily possible to prepare a re-emulsifiable powder in an aqueous medium, since any such attempt to copolymerize maleic anhydride, which is water soluble, would simply result in the hydrolysis of the vinyl acetate monomer due to the low *p*H imparted by the maleic acid which would be formed from the anhydride. However, National Starch Products (**28**), in a patent, disclose the copolymerization of the half ester only of a maleate, chloromaleate, fumarate or itaconate, with another monomer, but this patent excludes styrene.

Polyvinyl acetate holds a very important place among the resin emulsions produced in this country. Board of Trade statistics show that 5,159 tons of monomer were imported into Great Britain in the first six months of 1955, Canada and Western Germany each being responsible for about 40 per cent of the total imports. Actual production figures of emulsions are difficult to obtain, but it would be safe to say that the overall annual production, which was purely a token amount in 1945, was under 1,000 tons of polyvinyl acetate expressed as emulsion weight in 1949, and was upwards of 10,000 tons of emulsion in 1954.

The principal outlet for these emulsions is the paint industry, and approximately 75 per cent is consumed for this purpose, the resin being normally plasticized to about seven to 15 per cent of total solids weight. Very considerable advances have been made in recent years in the formulation of emulsion paints. Paints based on a polyvinyl alcohol stabilized emulsion were made extensively in Germany during the war (**29**). Most polyvinyl alcohol emulsions suffer from the defect that they yield films with insufficient gloss and clarity, although this is overcome in modern emulsions by careful choice of the grade of polyvinyl alcohol (see previous section). Many emulsions intended for emulsion paints are based on other stabilizers, and are formulated to give maximum stability, good brushability and flow down, and to dry to clear, glossy and water resistant films.

Basic Conditions

A number of articles have appeared on formulation, evaluation and plasticization (**30, 31, 32, 33**). The basic condition for a successful paint is satisfactory grinding and wetting of the pigment and a proper balance of wetting agents. Thus, where sodium carboxy-methyl cellulose is used as a thickener, it is desirable to add a non-ionic wetting agent, such as a polyethylene oxide derivative, whereas if methyl cellulose is preferred, sodium polymetaphosphate is more desirable.

The overcoming of specific defects in emulsion paints has been discussed (**34, 35**). Loss of viscosity may be due to biological action, and may be avoided by the addition of a suitable fungicide, while loss of adhesion of paint films can be overcome by proper formulation which will restore a proper adhesion/cohesion balance.

Freeze thaw stability of an emulsion is very important, particularly in countries where extremes of climate may be encountered. In order to obtain a freeze thaw

stable paint, it is advisable to use an emulsion which is itself stable after freezing and thawing. This can be imparted by the use of a suitable water phase in the manufacture of the emulsion. In addition, the use of a resin of comparatively high molecular weight, the addition of dioctyl sulph-succinate or sodium polymetaphosphate as dispersing agents, and the presence of the minimum possible quantity of plasticizer also assist in preventing emulsion paints being damaged when subjected to freezing.

The general properties of polystyrene based emulsions and polyvinyl acetate have been discussed by Hollis and Turner (**36**). Although claims have been made that polystyrene based paints have some advantages, such as better water resistance and freedom from hydrolysis, those prepared from polyvinyl acetate still hold the field.

Less Plasticizer

Polyvinyl acetate emulsions are generally far more stable at the high concentrations, about 55 per cent, required as a base for emulsion paints; they need a much smaller amount of plasticizer, and light resistance of films is much better.

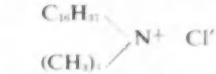
A lengthy symposium on polyvinyl acetate emulsion paint systems has taken place in the US (**37**). It should be noted that even in the US vinyl acetate based emulsion paints are effectively competing with those made with butadiene/styrene.

There has been a very marked interest in copolymers during the past few years, especially in the US. These are normally 'internally' plasticized with a suitable co-monomer, and thus do not need an external plasticizer such as dibutyl phthalate or the increasingly popular butoxyethyl phthalate. The nature of the co-monomers has not in general been revealed but it is known that ethyl or ethoxyethyl acrylate and butyl maleate are amongst the co-monomers being used, the proportion being about 10-20 per cent of the total monomer. The latest development in the United States is the use of vinyl stearate as a co-monomer (**38**). As this is now available in commercial quantities future development may be anticipated with interest.

Other resin emulsions which can be used effectively in emulsion paints are polyacrylates and polymethacrylates. Polybutyl methacrylate produces an exceptionally effective medium, but the cost is too high for all but special purposes.

There are outlets for polyvinyl acetate emulsions in all types of adhesives and binders, paper coating and impregnation, the coating of foodstuffs and foodstuff wrappings, as an additive in the beater stage of paper pulp, in flooring compositions and linoleum finishes, and in the finishing of textiles. This latter use is becoming of increasing importance. Resin emulsions are being used to give a crisp handle to sheeting, dress goods etc. and for semi-permanent finishing. Polyvinyl acetate has the advantage of good adhesion to cotton, wool, nylon, viscose and most synthetic fibres. The emulsion as supplied is diluted to about five per cent before padding on to fabrics. Another use is the addition to urea- and melamine-formaldehyde emulsions in shrinkproof and crush resistant finishes.

Resin emulsions can be prepared with 'cationic soaps', i.e. emulsifying agents of the type of cetyl trimethyl ammonium chloride



instead of the conventional anionic emulsifiers and colloids. Cationic materials assist the exhaustion of polymers on to fabrics and a well known use is that of anti-snag finishes for hosiery (**39**).

Polyvinyl alcohol, of a low saponification number, is used as a size for nylon, and a solution of 13 per cent polyvinyl alcohol and two per cent sodium alginate is an efficient size for Orlon (polyacrylonitrile fibre) (**40**).

The use of salts of polyacrylic acid has long been known for emulsifying and thickening agents, and a copolymer of methyl methacrylate (Rohagits) was used in Germany during the war. Considerable recent progress has been made, however, in the use of both acrylates and methacrylates as textile sizes (see J. H. Langston (**41**) and A. C. Nuessle and R. F. Crawford (**42**)). The latter have found that polyacrylic acid can be insolubilized on nylon by curing at 425°F for 25 seconds only, and that the use of a polyhydroxy compound renders the fixing still more efficient. Alkali soluble copolymers of methacrylic acid and methyl methacrylate of varying molecular weights

are now available from Vinyl Products Ltd. and are finding increasing applications in the textile field.

Various copolymers of methyl methacrylate and sodium methacrylate are also available. These products are in fact complex mixtures of varying proportions of poly sodium and methyl methacrylates. (**43**).

Most vinyl resins cannot be regarded as flameproof although the halogen containing polymers such as polyvinyl chloride and polyvinylidene chloride have considerable flame resistance. The use of a halogen containing polymer is objectionable for some purposes and a rather interesting development is the use of a vinyl resin containing phosphorus which has been patented by Kvalnes & Brace (**44**).

Typical Example

This phosphate compound can be formed from any hydroxyl-containing polymer, polyvinyl alcohol being the most obvious choice. It is reacted with a substituted phosphoryl halide. In a typical example diisopropyl polyvinyl phosphate is prepared by reacting 22 parts of a low viscosity 90 per cent hydrolysed polyvinyl alcohol with 97 parts of diisopropyl chlorophosphate in 392 parts of dry pyridine by stirring overnight at room temperature. The pyridine is then steam distilled with addition of sodium carbonate, and the viscous syrup of diisopropyl polyvinyl phosphate is separated.

The remaining hydroxyl groups in the resultant intermediate are then reacted with 2,4-toluene diisocyanate and the final product can be used in solution to impregnate cloth such as herringbone twill to give excellent flame resistant properties, after setting at 200-220°C for two to three minutes. The modified polyvinyl phosphate does not affect the properties of the cloth and dry cleaning has no effect on the additive.

The wide variety of uses to which vinyl resins, in particular in emulsion form, can be put, shows every sign of being further increased. New raw materials, such as butadiene, the production in bulk of which has been announced in this country, should increase the range of polymers and copolymers at the disposal of the research laboratories of industry. New developments will therefore be of considerable interest over a very wide range of potential applications.

The writer wishes to thank the directors of Vinyl Products Ltd. for permission to publish this paper.

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Dunkirk Bitumen Plant

At BP's Dunkirk refinery, work has begun on a bitumen production plant which will have a daily capacity of 500 to 700 tons of various grades of bitumen when it is completed late next year. The plant will supply internal markets in France.

Developments in Organic Analysis

A Survey of Modern Trends & Recent Methods in Ultimate & Functional Group Analysis

by T. S. WEST, B.Sc., Ph.D., A.R.I.C.
(Department of Chemistry, University of Birmingham)

THE most noticeable trend in organic analysis during the past few years is the increasing use being made of rapid automatic and semi-automatic methods of ultimate analysis. Some semi-automatic apparatus for the ultimate analysis of carbon, hydrogen, nitrogen etc., in organic compounds is now available commercially and many laboratories are replacing their classical apparatus by these new devices.

Another important trend which appears to be developing is the attention which is being paid to functional group or structural analysis. A recent 'editorial' in *The Analyst* (**1**) stresses that in connection with the considerable work now in progress on the elucidation of the structure of large molecules, it is difficult to determine the exact empirical composition of the molecule by the established methods of classical ultimate analysis and molecular weight determination.

The exact molecular weight of insulin has recently been established as 5,734 and the empirical formula as C_{254} H_{377} O_{75} N_{65} S_6 (**2**). The commentary (**1**) points out that the knowledge of structure was precedent to the accurate knowledge of composition. This is the exact reverse of the normal run of events both in organic and inorganic chemistry, where a knowledge of empirical formula has usually been necessary before the elucidation of structure.

Structure of B_{12}

The recent unravelling of the structure of the vitamin B_{12} molecule by other workers (**3**) illustrates the self same process. In both these analyses use was made of techniques such as chromatography and electrophoresis, and in the latter case considerable use was made of ultra-violet and infra-red spectroscopy, and of X-ray crystallography.

These two examples are perhaps extreme cases, but they serve to focus attention on the increasing demand for use of functional group determinations in organic analysis. As far as less complicated structures go, it is not envisaged that the classical methods of ultimate analysis will be superseded, but it has become increasingly obvious that the microanalysis laboratory of the future will be required to pay considerably more attention to group or structural analysis.

A recent publication (**4**) from 'Interscience' has done much to reveal how modern techniques of instrumental analysis can be employed with advantage. Methods are described for groups such as hydroxyl, alkoxyl, active hydrogen, carbonyl, acetal, sulphur, carboxyl, ester, nitro, nitroso and nitrate etc., and special chapters are devoted to the organic application of techniques such as coulometry, polarography, phase solubility, countercurrent distribution and methods based on reaction rate.

Semi-Micro Techniques

Macro methods of analysis have largely been displaced by micro methods although there is a tendency for reversion to the simpler semi-micro techniques to occur. In what follows, remarks will therefore be confined solely to micro- and semi-micro methods of analysis.

The literature abounds with numerous methods for the determination of carbon and hydrogen. On the whole, these are based on the classical slow procedure developed originally by Liebig and subsequently modified by others, notably Pregl. Undoubtedly the most rapid method for the micro-determination of carbon and hydrogen is the rapid empty-tube method due to Belcher and Ingram (**5**). Using a rapid oxygen flow of *ca.* 50 ml. per minute in an empty tube at a temperature of 900°C. combustion is complete in 10 minutes.

Interfering substances such as sulphur and halogens are removed on heated silver gauze and nitrogen oxides in an external manganese dioxide absorber. This external absorber has proved to be one of the most efficient methods of removing nitrogen oxides yet proposed. Recent work (**6**) has shown that manganese dioxide suspended

on platinum asbestos may be used as an internal packing for 'slow' combustion trains, but it is our experience that the asbestos is itself a source of error (7).

The vexed question of nitrogen oxide removal has been studied by many authors. Cross and Wright (8) have suggested the external use of tris-hydroxylamine phosphate and sulphamic acid in place of the capricious, classical lead peroxide reagent. Hussey, Sorensen and De Ford (9) prefer to use ammonium sulphamate dispersed on silica gel (external). Kirsten (10) prefers the manganese dioxide reagent of Belcher and Ingram (11). French workers (12) have advocated the use of diphenylamine-sulphuric acid adsorbed on alumina as an external absorbent.

Nitrogen-Oxide Absorbent

Cropper (13) has made a thorough examination of various preparations of lead dioxide for use as nitrogen-oxide absorbent. He concludes that the variability of different batches is due to differences in particle size, and claims that an efficient product may be obtained by the action of sodium hypochlorite on lead acetate, or by ball milling coarser products. Granules of high absorptive capacity tend to give erratic carbon results, but a product of medium quality gives satisfactory behaviour in a 'packed' tube and has a long life. It is to be presumed that analogous behaviour would be found with boat filling of the lead dioxide. On the whole, the manganese dioxide method appears to be as simple and trouble free as any.

Some authors have explored new methods of carrying out the determination of carbon and hydrogen. One of the most novel methods is a titrimetric one due to Johansson (14). He points out, quite rightly, that the chief source of error in the classical gravimetric methods is the weighing of minute amounts of carbon dioxide and water vapour in comparatively large glass absorption vessels. This difficulty is overcome by using a titrimetric finish, so that only the sample need be weighed.

Using a 10 ml per minute oxygen flow rate with an empty tube at a temperature of 900°C, Johansson absorbed the water vapour first in a mixture of methanol and pyridine and passed the gas stream through a water scrubber (to remove methanol), he then led it through a solution of sodium hydroxide (0.2N) and barium chloride (0.05M). The water absorption vessel was then emptied and the water content titrated by standard Karl Fischer reagent, while the precipitated barium carbonate was filtered off, dissolved in hydrochloric acid, precipitated as barium iodate, and finally determined by the standard iodimetric step-up procedure.

This method is an extremely interesting one, particularly in that it utterly rejects the classical baryta titration method for carbon dioxide, and that it uses the Fischer water reagent. It can hardly be hailed as an advance of practical value, however, as it necessitates careful precautionary measures throughout the procedure, and in addition involves the use of a correction factor of 1.019 on the carbon analysis. Nevertheless the importance of this new departure is to be emphasized.

Another most interesting method also comes from Swedish laboratories. In a preliminary note on this new procedure for the simultaneous determination of carbon, hydrogen and nitrogen, Kirsten (15) describes how the organic compound is combusted in a sealed quartz tube containing a measured amount of pure oxygen over mercury. Any nitrogen oxides formed are decomposed by heated copper. The gases are measured by the usual procedures of gas analysis or in a mass spectrometer.

Wet Combustion Procedures

Archer (16) has suggested a semi-micro wet combustion procedure and Van Slyke (17) has reviewed wet combustion procedures. Combustion in a quartz tube with moist oxygen has been used for the determination of carbon and fluorine in highly fluorinated organic compounds (18). The fluoride was determined by acid-base titration and the carbon gravimetrically in the usual way. Gelman and Korshun add magnesium oxide to the sample when fluorine is present (19). This device was previously reported in an American journal (20). Sirotenko (21) adds potassium persulphate to the combustion boat when the compound contains alkali metals, thus preventing the formation of thermally stable carbonates.

Next to the carbon-hydrogen analysis, the determination of nitrogen is perhaps most in demand. Several adaptions of the classical Kjeldahl and Dumas methods have recently been forthcoming. Very many modifications of Kjeldahl method have

been proposed, but relatively few on the Dumas method. In connection with the latter, however, the rapid, double tube method of Schöniger (**22**) is noteworthy. There appear to be few snags to this new departure from established practice, and it is known to work efficiently for a wide variety of samples. Sources of error in the normal Dumas method have been studied extensively (**23, 24**) and methods of circumventing them have been suggested.

Many authors propose different catalysts for the Kjeldahl digestion. Mercuric sulphate and selenium appear to be the most used, and even here there appears to be a definite leaning towards the use of the mercury salt. Dickinson (**25**) has directed attention towards the tendency for low results to be obtained on chlorine containing nitro compounds due to the formation of nitrosyl chloride.

The reduction of the nitrate group by various methods has been examined, *e.g.* with zinc and methanol (**26**), salicyclic acid (**25**), sulphosalicyclic acid (**27**), α-naphtholpyrogallol (**28**), glucose (**29**) or chromous chloride (**30**). Beet (**31, 32**) has shown that coals and certain other organic materials can be decomposed rapidly without the addition of either potassium sulphate or a catalyst to the sulphuric acid. Decomposition is effected quickly and safely by gradual addition of permanganate crystals to the boiling digest of sulphuric acid till all the organic matter has disappeared and a permanent grey-green colour persists.

Steam Distilled

The ammonia is steam distilled in the usual way and titrated normally. This method appears to have the advantages of rapidity and wide application. Belcher (**33**) notes that this method is more akin to the original Kjeldahl procedure than any other of the host of modifications that have been practised in that name for the past half century.

White and Long (**34**) described a sealed tube digestion procedure, using a mercuric acid catalyst with sulphuric acid at a temperature of 470°C. However, they showed that under the conditions obtaining in a sealed tube the catalyst was sometimes not necessary, *e.g.* in the case of nicotinic acid —a substance known to be refractory in yielding up all its nitrogen as ammonia. Kirk and co-workers (**35**) examined the method and obtained excellent results without the aid of a catalyst at a temperature of 40°C. The ammonia was liberated by diffusion technique (on the deci-milligram scale) and titrated with standard hydrochloric acid.

A later paper from the same source examined the loss of nitrogen from various sources. It was established that the optimum temperature below which loss of ammonium ion was not significant was 500°C. These effects have been examined independently elsewhere and substantially confirmed (**36**). Dixon (**37**) has utilized the sealed-tube method, but she retains the catalyst and distills the ammonia. Baker (**29**) has verified the results of White and Long, but restricts the temperature to a maximum of 440°C.

Nitrogen Determination

A new method for nitrogen determination has been devised by a Japanese author (**38**). The compound is digested with iodic acid in phosphoric acid at a temperature of 260°C till no more gas is evolved and no more iodine is liberated. The nitrogen is measured directly in a nitrometer over caustic potash. Schöniger (**39, 40**) describes an elegant new method for nitrogen in which the compound is fused with powdered magnesium. The magnesium nitride formed is determined by distillation of ammonia in the Kjeldahl manner.

Considerable work has been directed towards the evolution of more satisfactory methods for the analysis of the halogens and sulphur. Fleuret (**41**) has devised an unusual method in which the organic compound is decomposed by fusion with silver nitrate. The silver halides can be weighed directly while the sulphate can be washed out with ease.

Another unusual method for halogens has been devised by Liggett (**42**). A solution of diphenyl sodium in 1,2-dimethoxyethane is used to remove the halogen from the compound being analysed. The procedure which is based on earlier work by Benton and Hamill (**43**) consists simply of shaking up the sample with the reagent solution, extracting with water and applying conventional volumetric or gravimetric methods (**44**). Schöniger's nitrogen decomposition method (**39, 40**) may also be extended to the simultaneous determination of halogens and sulphur. The sulphur is

determined by evolution of H_2S and iodometric titration while the halogen is determined by a Volhard titration of the distillation solution. Certain aspects of this method have much to recommend it over the conventional alkali metal fusion methods.

Another method has been described in which the four halogens or any combination of them can be determined after fusion with sodium in a nickel bomb at a temperature of about 600°C (**45**). The wide coverage of this method and the accuracy obtainable is very attractive. Another method (**46**) requires sealed-tube digestion of the sample with nitric acid and silver nitrate. The silver halides are eventually reduced with hydrazine and the precipitated silver metal is weighed, or the halide in solution is titrated. Since the weighing of silver metal involves a slight decrease in terms of conversion factor, the titrimetric method would appear preferable. On the other hand (**47**) it has been shown that it is not possible to get accurate results on the potentiometric titration at levels below 0.1 mg.

Unusual Method

A recent unusual method for halogens involves the suspension of the weighed sample in an ashless filter paper over hydrogen peroxide and caustic potash in a conical flask (**48**). The flask is filled with oxygen, the paper is then ignited and the flask is stoppered and shaken for 10 minutes to absorb all the acid combustion products. Standard titrimetric procedures were used to determine all three halogens. It is claimed that an accuracy of ± 0.3 per cent may be obtained by this most unusual combustion method.

Decomposition of halogen compounds using Raney nickel in alkaline solution has been utilized by Hungarian authors for the determination of chlorine, bromine and iodine in certain compounds (**49**). The method would appear to be restricted to a certain class of compound, however. Zinc and sulphuric acid in the presence of palladized charcoal have also been used for other classes of compound.

Kirsten (**50**) has described a method for sulphur in organic and inorganic compounds where the sample is combusted in oxygen. After passing through a capillary, the gases meet a stream of hydrogen. In the oxygen-hydrogen flame the sulphur oxides are reduced to hydrogen sulphide and a small amount of elementary sulphur. The products are absorbed in alkali and the sulphide and polysulphide are determined by hypochlorite titration.

Others (**51**) approach the problem through combusting directly in hydrogen over a platinum catalyst at a temperature of 850°C and finish off the analysis iodometrically. Phosphorus interferes with the method. Sulphur is held back in the normal oxygen tube combustion method when alkali or alkaline earth metals are present in the compound. It has been found (**52**) that the addition of an excess of B_2O_3 to the sample in the combustion boat prevents this loss.

Pietsch (**53**) has studied the determination of arsenic in organic compounds containing practically any other common metal and the halogens. The compound is digested in a Kjeldahl flask with nitric acid/sulphuric acid and a copper catalyst. The digest is diluted and treated with barium nitrate to remove sulphate, the neutralized filtrate is then treated with excess silver nitrate and the unused part is back titrated with ammonium thiocyanate in the Volhard manner.

Czechoslovak workers (**54**) achieved the decomposition of the organo-arsenic compound by heating with a 3+1 mixture of magnesium and magnesium oxide in a sealed tube. The arsenic, thus converted to magnesium arsenide, is determined by treatment with dilute sulphuric acid, whereby the arsine evolved is passed into a 0.5 per cent solution of silver diethyldithiocarbamate in pyridine. The colour produced has an adsorption maximum of 560 mμ and is proportional to concentration up to 20 μg. of As per ml. of solution. Levy (**55**) determines arsenic, after decomposition of the organic compound, by precipitation as silver arsenate and back titration of the excess silver using potassium chloride.

Determination of Phosphorus

Burton and Riley (**56**) have described a method for the determination of phosphorus in organic compounds. Following decomposition of the sample in a peroxide bomb, the resulting phosphate is determined by a modification of the usual spectrophotometric molybdenum blue method.

The determination of alkoxy groups is of prime importance in organic analysis

generally. Thus, knowledge of the alkoxyl oxygen content of a compound permits the calculation of the lowest possible molecular weight. Very many organic compounds of medicinal value (alkaloids), commercial value (cellulose and sugars) and research compounds contain alkoxyl groups. Most alkoxyl methods stem from the original Zeisel method in which the methoxyl groups were removed as methyl iodide on reaction with constant boiling hydriodic acid. This then reacted with alcoholic silver nitrate, which on acidification deposited silver iodide. The latter was filtered and weighed to give a measure of the methoxyl content to within ± 0.5 per cent.

Very many modifications of this method exist. One of the most useful is that due to Vieböck and Brecher (**57**). This is a titrimetric method in which the alkyl iodide is caused to react with bromine in glacial acetic acid forming iodic acid. This is subsequently treated with potassium iodide and mineral acid and the liberated iodine is titrated with thiosulphate. This modification of the Zeisel procedure has generally found favour with most chemists particularly since it supplies a titrimetric finish with six molecules of thiosulphite being required for each alkoxyl group in the original sample. Modifications of apparatus and technique vary with the alkoxyl group being determined.

Hydroxyl Group

The analysis of hydroxyl group is also of prime importance. Here, there is a much wider variety of methods available. Hydroxyl groups attached to primary and secondary carbon atoms are almost invariably determined by an esterification method, e.g. by reaction with acetic anhydride or acetyl chloride, with phthalic anhydride etc. The excess of esterifying agent can be determined after water hydrolysis by alkalimetric titration or alternatively the ester formed can be determined by gravimetry etc.

Phenolic hydroxyl groups can be determined by bromination or by coupling with diazo compounds generally. Special methods such as periodate oxidation are available for the determination of vicinal hydroxyl groups, and of course the all-embracing active hydrogen method may be used.

This technique which involves the reaction of the hydroxyl group with a Grignard reagent such as methyl magnesium iodide, results in the formation of methane which can be collected and measured volumetrically or manometrically or which can be combusted and measured as $CO_2 + H_2O$. Methods based on the use of Grignard reagent are particularly useful for the determination of tertiary hydroxyl groups, which are not amenable to treatment by the more conventional esterification techniques. These methods are on the whole less accurate than esterification procedures.

Acetyl Group

Another analysis frequently sought in this field is the determination of acetyl group. Here again many methods have been devised, but the most satisfactory is that finally devised by Wiesenberger (**58**). The lack of precision obtained in earlier methods was due to the presence of sulphuric acid in the distillate, according to Wiesenberger. He overcame this source of trouble by using an ingenious re-vaporization technique. This method is so efficient that phosphoric acid may be used as the saponifying agent. The acetic acid is collected systematically in a stepwise manner, keeping the volume of boiling liquid in the flask reasonably constant. The acetic acid is titrated with sodium hydroxide using phenolphthalein as indicator.

It should be stressed that the success of the Wiesenberger method is almost entirely due to apparatus design. The same apparatus can be used for the determination of methyl groups directly bonded to carbon, with chromic acid as the oxidizing agent. A quantitative yield of acetic acid is not obtained from methyl groups attached directly to an aromatic ring or from the methyl radicals in *gem*-dimethyl and tertiary butyl groups.

This survey began by recommending an American text-book which deals particularly well with modern developments in the application of new analytical techniques. One technique not covered specifically in this work is the organic application of titrimetry in non-aqueous media. This technique, as yet not covered in any standard text, is most valuable in organic analysis for the determination of several functional groups e.g. carboxyl, amino, nitrogen, phenolic hydroxyl, enols, nitro groups etc. The tech-

nique has already been briefly reviewed in THE CHEMICAL AGE (**59**).

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Electronic Computer

THE electronic computer system for the automatic analysis of chemical compounds, developed by L. Pinteric and M. D. Poulie, has been further improved at the Department of Hygiene and Preventive Medicine, University of Toronto, Canada. The computer analyses complex chemical compounds such as mixtures of proteins, by automatically scanning the stains left on a filter paper by the processed and dyed chemicals. Results of readings appear as a series of curves on the screen of the cathode ray oscilloscope.

The improved system electronically measures the area enclosed by the curve on the oscilloscope. The pattern and area enclosed by the curve records the presence of each individual chemical compound in the mixture and the quantity in which it occurs. The computer then evaluates the amount of each individual compound present in the mixture in terms of percentages of the total amount of the mixture present on the area of paper it has inspected.

Although the device has been developed primarily for medical use, it can equally well be used for evaluating a variety of industrial chemical analyses.

Huddersfield Tip Blaze Sequel

At the meeting of Huddersfield Town Council on 4 January, the general purposes committee submitted a recommendation that a claim be made against L. B. Holliday & Co. Ltd., aniline dye manufacturers, Deighton, Huddersfield, owners of the tip at Bradley which was the scene of a disastrous blaze last September. The claim is for recovery of damages and expenses incurred by the corporation as a result of the fire.

Change of Address

Messrs. L. D. Galloway, M.A., M.I.Biol., and E. C. Barton-Wright, D.Sc., F.R.I.C., microbiological and biochemical consultants, have moved to Haldane Place, London SW18 (telephone: BATtersea 7744).

Climbing Film Evaporator

I.Chem.E. Hear Paper on Heat Transfer

A MEETING of the North-Western Branch of the Institution of Chemical Engineers was held at Manchester on 17 December when a paper on 'Heat Transfer in a Climbing Film Evaporator' was presented by Professor J. M. Coulson, M.A., Ph.D., and Mr. M. J. McNelly.

Dr. Coulson gave a continuation of the work of Coulson and Mehta where the temperature difference over the boiling film, the feed rate and the viscosity of the liquor boiling in a long tube were related to the heat transfer coefficient of the boiling film for which the values for low temperature differences were higher than those for nucleate boiling but the relative values of the coefficient, h_b, at higher temperature differences were in doubt. The present work resolved that doubt, gave an account of the mechanism of the evaporation and provided a general correlation of the results.

Coefficients Obtained

Tubes, 5 ft. 3 in. long, of silver, copper or stainless steel, were heated externally by hot water at pressures up to 100 psig. The vapours from the liquids in the tube were sent to a cyclone separator, were condensed and measured. Evaporations were done under vacuum and the liquid feed to the tube was preheated to its boiling point and was measured. The overall coefficient and the film coefficient of heat transfer for the heating medium were obtained experimentally and were used to calculate h_b.

A series of tests was done on $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1 in. diameter silver tubes. At low temperature differences, h_b was proportional to a fractional power of the temperature difference, this corresponded to forced convection heat transfer and the increases in h_b were caused by increases in the velocity of liquor flowing up the tube; an increase in the rate of the feed at its boiling point had a similar effect. These coefficients were higher than those for nucleate boiling but their increases with increases in temperature differences were lower; therefore there was a temperature difference when the mechanism of heat transfer changed to nucleate boiling and h_b increased rapidly with only a small increase in temperature difference; the feed rate then had no influence on h_b. This change would occur at different temperature differences for different liquids but h_b for all liquids was proportional to the temperature difference raised to a similar constant power.

At high temperature differences total or nearly total evaporation took place, h_b decreased as the temperature difference increased and the heat transferred remained constant. The value of h_b for forced convection was inversely proportional to the tube diameter and a change from a silver to a copper tube did not change h_b significantly. The h_b was measured between the bottom of the tube and between five equally spaced points along its length, h_b increased with the increased turbulence caused by increases in the amount of vapour in the liquid as the mixture rose up the tube.

Nucleate boiling occurred at the bottom of the tube. Forced convection heat transfer occurred when the velocity of the liquid increased because of increased evaporation. It could be predominant when the temperature difference was high enough for nucleate boiling to take place. Equations for the ranges of forced convection heat transfer and of nucleate boiling expressed the experimental results in a useful form.

Schaffer Poidometer Rights

SOON after Mr. R. S. Harding, the technical manager of Sheepbridge Equipment Ltd., returned from an eight-weeks' tour of the US recently the company announced that new additions to their range of mining and quarrying machinery could be expected. Now the company announce that they have acquired the rights to manufacture the Schaffer poidometer, an accurate feeder-weigher, which can handle all crushed, granulated and pulverized matter used in the mining, milling, smelting, refining and concentrating industries.

Extensively used in the US to weigh and feed coal to furnaces and driers, and at the same time to keep accurate fuel consumption records, the poidometer is employed in mechanical plants to handle such materials as bauxite, phosphate rock, soda ash, soap powder materials, alum and lime.

New Flameproof Switch

Designed to Meet BSS 229 & 587

BURTON, Griffiths & Co. Ltd. announces that a flameproof snap-lock limit switch has been designed to comply with the requirements of BSS 229 and 587. For some time, a number of these switches have been used in collieries where their operation has proved satisfactory.

The mechanism of the new switch is identical with that of the standard 16D-1200 range of snap-lock limit switches introduced in 1953. Although for colliery work the only protection required is against Class 1 gases, such as methane, the new switch is claimed to be safe against Class 2 and 3 gases which include blast furnace gas, hydrocarbons encountered in the petroleum industry, liquids derived from coal tar, industrial solvents such as cellulose solvents, coal or towns gas and coke oven gas. The switch has passed the appropriate tests of the Ministry of Fuel and Power at the Buxton testing station and is licensed to carry the Ministry's official FLP mark.

The flameproof switch is a single phase, or DC double circuit, or two-way switch having one normally closed and one normally open circuit, which can be reversed by moving the return spring to the side required.

To comply with the National Coal Board's directive that no aluminium die casting may be used in dangerous locations, the switch is housed in Meehanite iron castings.

All plugs and sockets are interchangeable in all respects so that it is possible to replace a switch in a few minutes. The switch supplied as standard operates in a clockwise direction.

The surfaces of the cast iron parts are Parkerized finished and coated with P.41 Pyrene lacquer, and other bright parts are heavily plated with cadmium. Normally, the standard type of operating lever is supplied, but a number of special levers to meet particular requirements are available.

All UK inquiries in connection with snap-lock switches should be made to Burton, Griffiths & Co. Ltd., snap-lock division, 93 Albert Embankment, London SE11, and overseas inquiries to BSA Tools Ltd., Small Tools Division, Export Department, Montgomery Street, Sparkbrook, Birmingham.

The BSA Snap-lock

Shawinigan Research

SHAWINIGAN Resins Corporation, Springfield, Mass., one of the companies associated with Shawinigan Chemicals Ltd., has opened a new addition to its research building. Announcing the opening, Dr. R. N. Crozier, director of research, stated that the addition will more than double the company's research facilities. The new three-storey wing contains equipment for conducting basic research, process and product development and end-use research, and is the first step in a long range programme of expansion.

Construction of a second addition, which will cost more than $300,000, will start immediately and should be ready for occupation by the end of 1956.

Committee's Scope Widened

In the third report of Professor Zuckerman's Working Party on risks to wild life arising from the use of toxic substances in agriculture which was published on 23 June 1955, there was a recommendation that the terms of reference of the advisory committee on Poisonous Substances used in Agriculture & Food Storage should be widened to include such risks. This has now been fulfilled by the appointment to the advisory committee of two members of the staff of the Nature Conservancy, Miss O. E. Balme, M.Sc., and Mr. R. E. Boote, B.Sc.

The Constitution & Properties of Soil Organic Matter

by JOSEPH TINSLEY, Ph.D., F.R.I.C.
(Department of Agricultural Chemistry, University of Reading)

THE scientific study of a soil begins with an examination of a profile section in its natural setting by digging a pit for the purpose, or by making use of recent excavations such as a railway or road cutting, trench or post hole.

Commonly, such a profile reveals a succession of several horizons differing in colour and composition from the surface downwards as the soil emerges into the underlying parent rock material; and usually the most striking feature to be observed is the accumulation of organic matter in the uppermost horizons. The solid phase of the soil is thus seen to be a heterogeneous mixture of organic matter largely derived from the decay of roots and leaves with mineral particles derived from the parent rock or drift material below.

Soil Characterization

Frequently the soil is characterized by a definite structural arrangement of the mineral and organic matter into aggregates or crumbs which are built together in a peculiar kind of architecture to form a labyrinth of pores and channels. Within these cavities, in ever changing distribution, are the water and air so necessary for plant growth. The study of the soil's architecture, both in the arrangement of the particles and the complementary pattern of the pore space, has assumed considerable importance in recent years because of the growing recognition that such physical factors as permeability to water and air, and retention of water within root range do influence plant growth to a marked degree.

Furthermore, the ease of cultivation and stability of the soil, especially in areas subject to erosion, greatly affect farming operations. The title of a recent American book edited by Shaw (1) serves to emphasize the current interest in these topics, but it should not be concluded from the foregoing remarks that the soil is merely an inert porous medium to hold plant roots.

Fig. 1 is a photograph of five soil profiles collected in the neighbourhood of Reading, and mounted by impregnation with a solution of a vinyl resin. They show a wide range of physical characteristics, the soils being developed on such diverse parent materials as chalk, gravel, sand, clay and river alluvium. In each case the accumulation of organic matter is most evident in the surface horizon though the amounts vary considerably.

The varied distribution of organic matter is further illustrated by Fig II which shows the content of each horizon in five soils examined by Kay (2) in a survey of the strawberry district of South Hampshire. Organic matter is most abundant at the surface but whereas in four of the soils it decreases with each succeeding horizon, in the Southampton series there is a secondary band of accumulation well below the surface. This feature is characteristic of the very acid podsolic soils found under a pine wood or heath type of vegetation where some colloidal organic matter is dispersed in the surface, leached downward, and precipitated as a dark coloured lower layer.

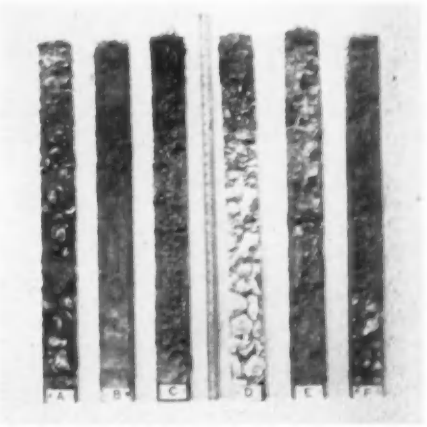

FIG. 1. Soil Profiles From Reading Area A—Neville series on gravel B—Rowland series on sand C—Clay loam under pasture D—Chalk soil E—Woodland soil on clay loam overlying gravel F—Alluvial loam under pasture

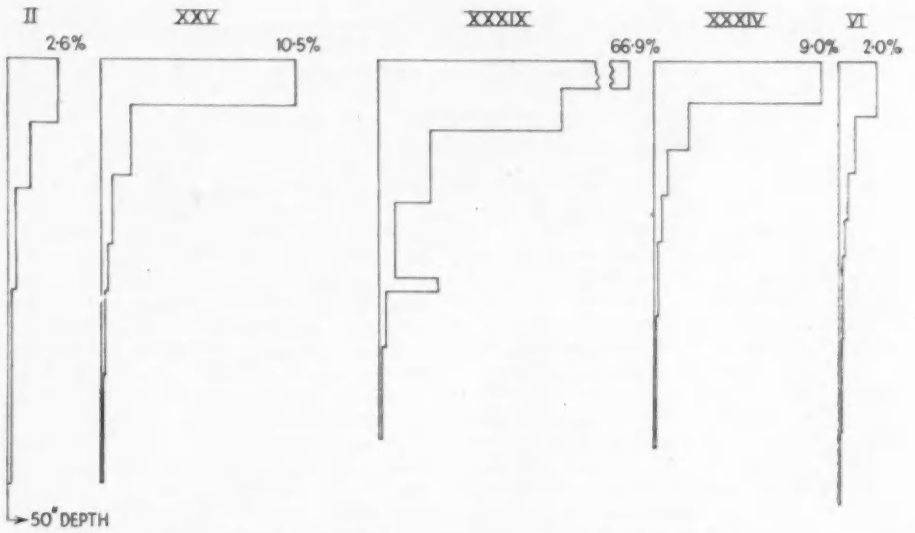

Fig. II Organic Matter Content of South Hampshire Soil Profiles (Kay)
II Hamble series: Fine sandy loam—cultivated; XXV Burlesden series: Sandy loam—oak woodland; XXXIX Southampton series: Gravel—gorse heathland; XXXIV Swanmore series: Clay loam—pasture; VI Shedfield series: Fine sand—cultivated

Closer inspection in the field coupled with detailed examination in the laboratory shows the organic matter from different soils to vary considerably in composition and properties as well as in amount and distribution within the profile.

Besides being the medium for root growth of higher plants the soil also shelters vast numbers of insects and other invertebrate fauna, including earth worms; and a myriad populace of micro-organisms. To these, the soil is birthplace, home, feeding ground, refuse dump and burial ground. Each species vies with the other and mostly they compete with plants for the available nutrients released by decay. To regard the soil as a living thing in itself as Balfour (**3**) and some other writers have implied is perhaps too fanciful, but certainly it is the habitat of a living community and soil biology has assumed full status as a section of soil science. This was the theme of a recent conference at the University of Nottingham, the proceedings of which have just been published (**4**).

Between these two extremes of soil physics and soil biology and linking them together is the rather diffuse province of soil chemistry which may involve on the one hand advanced studies in the physico-chemistry of colloidal silicates or, on the other hand, an intricate knowledge of organic and biochemistry according to whether the interest is mainly in the mineral fraction or the organic fraction.

To the chemist the organic matter accumulated in any particular soil represents a quasi-equilibrium between the rate of addition of fresh organic residues and the rate of decomposition. Soil samples always include a proportion of fresh plant tissues, especially roots and such leaves and stems as may be incorporated either naturally or by ploughing in materials like straw and green manures. Grass species have a marked ability to accumulate organic matter in root tissues and Russell (**5**) has quoted results of a study by American workers on a prairie soil in Nebraska where the weight of dry root tissue in the top six inches of soil was 8.5 per cent of the total organic matter but only 2.8 per cent in the underlying six to 12 inches.

In the normal process of drying and sieving the sample for laboratory examination the coarse plant residues are removed together with any of the larger insects which may be present but the finer shrivelled root

hairs mostly pass through a two mm. sieve and are included in the fine earth. This fine earth also includes the tissues of a host of micro-fauna and numberless bacteria, fungi, actinomycetes and other micro-flora.

It is extremely difficult to estimate either the precise number or weight or composition of these micro-organisms but Russell made a tentative estimate for an arable soil at Rothamsted containing three per cent of organic matter in the top six inches. In all, the micro organic tissue amounted to about 1,000 lb. of dry matter per acre or something between one and two per cent of the total organic matter.

Assuming that the finer plant tissues are present in similar quantity it is reasonable to conclude, at least for soils under cultivation, that the total amount of 'fresh' cellular tissue is usually no more than five per cent of the total organic matter in samples prepared for laboratory study.

Thus by far the major portion of the organic matter is composed of various decay products derived from the fresh tissues. This is the material commonly known as humus which has a brown or blackish colour and possesses colloidal properties of water retention and cation absorption of considerable practical importance in soil fertility. Current research is very much concerned with the function of humus in the formation and stability of soil aggregates as the very recent review by Martin (**6**) *et alia* reveals.

Environmental Conditions

Not only does the amount and chemical composition of organic residues added to soils vary with the type of vegetation and stage of growth or with the system of farming but the course of decomposition is greatly affected by the influence of environmental conditions on the activities of soil organisms, and hence the humus fraction of different soils may be expected to vary in composition and properties.

The overall rate of decomposition may be measured by the production of carbon dioxide as the final product in the chain of oxidation reactions, although under the intensely anaerobic conditions in peat, gaseous products such as methane are also formed The results of numerous experiments show that decomposition is controlled by three major factors, namely the water supply, air supply and temperature of the soil although sometimes the supply of essential mineral elements may be critical. Thus in cool wet climates the rate of turnover is slow and peat readily accumulates while in tropical regions organic matter is rapidly decomposed.

Intense acidity in podsolic soils prevents earthworm activity and limits the decay of leaf litter which accumulates at the surface. Humus, then, is not a single substance with mysterious properties but a complex of the more resistant organic residues in various states of decay mixed with the metabolic products of the soil organisms which accrue as a balance between micro-organic synthesis and decomposition.

Separation Difficulties

The initial difficulty in any chemical study of the organic matter of soils, other than pure peats, is that of separating it as completely as possible from the mineral matter which usually is by far the major portion of the soil. Many workers have tried to dissolve the organic matter with suitable aqueous or organic solvents but so far a complete separation of the mineral from the organic components has not been achieved. Others have sought to study the organic matter without attempting to separate it in its original condition by applying hydrolysis or other degradation procedures directly to the whole soil. In the discussion which follows results obtained by both these approaches will be considered.

The earliest chemical examination of soil organic matter worthy of mention in detail is that of Sprengel (**7**), published in Germany in 1826. He treated peat and soils first with dilute acid to dissolve the bases and release what he termed the 'humic acids'. The sample was then washed free of mineral acid with water and digested with dilute ammonium hydroxide for several days. A brown liquid was obtained which could be filtered from the mineral residue and when the filtrate was acidified it gave a precipitate of crude 'humic acid'.

This contained much ferric iron and appeared to be contaminated with fine clay so it was re-dissolved in dilute sodium carbonate solution and the 'humic acid' reprecipitated with cold dilute hydrochloric acid. Sprengel recognised that a considerable part of the humified organic matter present in the soil was not extracted by

this treatment and this fraction which remained insoluble in the soil residue was later termed 'humin' by Berzelius and his pupil Mulder (**8**).

The principles of Sprengel's procedure for extraction and preliminary fractionation of soil organic matter are still followed though there have been many modifications in points of detail. No very significant advances followed until early in the present century when Odén (**9**) in Sweden pursued the study of the 'humic acid' precipitate further and attempted to purify it by repeated solution in alkali and reprecipitation with acid. From peat he obtained a material with distinctly acid properties which he considered was a specific substance with the empirical formula $C_{60}\ H_{72}\ O_{24}\ (COOH)_6$.

Partial Oxidation

After many reprecipitations the nitrogen content was reduced from 2.5 per cent to only 0.7 per cent and Odén considered this nitrogen to be an adventitious impurity. In this view he was probably influenced by the opinion of many previous workers that humic acid was derived from partial oxidation of the cellulose present in plant tissues. Odén found, as others had done, that after separating the humic acid from an alkaline soil extract, much organic matter remained in solution and this he termed the 'fulvic acid' fraction because of the usual yellow-brown colour of the solution.

These two terms the 'humic acid' and the 'fulvic acid' fractions are still widely used in soil science terminology especially by Russian and German workers despite the fact that the division is now recognized as being rather arbitrary. Forsyth (**10**) clearly showed that the first precipitate obtained with acid at *p*H 2 contains much polysaccharide material which may be hydrolysed away by boiling with dilute hydrochloric acid to leave a more resistant residue.

Contemporary with Odén, Schreiner and Shorey (**11**) and their associates in America isolated a wide range of simple organic compounds in relatively pure but small yield from soils direct, from their humic acid precipitates and particularly from their fulvic acid fractions. These compounds included sterols, fats, waxes, organic acids, sugars and a wide range of nitrogen compounds, including amino acids, amides, amines, purine and pyrimidine bases, most of which are now recognized as intermediates of protein and nucleic acid metabolism. Thus the pattern of the chemistry of soil organic matter became very complex.

Gradually emphasis was focused on the forms of nitrogen in the organic matter as it became clear that the supply of ammonium and nitrate forms to higher plants, other than species with symbiotic nitrogen fixing bacteria, was largely maintained by the action of micro-organisms on the complex nitrogen compounds of the humus. Normally no more than about two per cent of the total nitrogen in the soil is present as inorganic forms. Following the first attempt by Shorey, several investigators, particularly in America, applied the standard method of protein hydrolysis with constant boiling hydrochloric acid directly to soils. Morrow and Gortner (**12**) found that about three quarters of the total nitrogen was dissolved in this way and, using Van Slyke's method for nitrogen distribution, about one third was determined as amino acids.

They established that the presence of carbohydrate materials can markedly change the pattern of the nitrogen distribution in a protein hydrolysate as also can the mineral matter of soils and they suggested that the high yield of insoluble 'humin' was due to side reactions leading to the condensation of amino acids with furfuraldehyde or other such compounds.

Ninhydrin Reaction

A further 20 years was to elapse before more precise information on the forms of nitrogen emerged from the studies of Kojima (**13**) in America and of Bremner (**14**) at Rothamsted. By using the highly specific ninhydrin reaction it was established that at least one third and possibly as much as one half or more of the nitrogen in the organic matter of many soils is present as α-amino acids. Next, by applying the technique of partition on a paper chromatogram Bremner (**15**) identified and made a semi-quantitive estimate of some 22 individual amino acids in hydrolysates from several soils. Still more recently Bremner and Shaw (**16**) have determined glucosamine and they consider this may account for up to one tenth of the total nitrogen in soils.

Despite these important steps forward the original nature of the polymers from which these amino compounds are derived by acid

hydrolysis still remains largely unsolved. It is assumed that the amino acids come from proteins or polypeptides but as yet no one has succeeded in isolating more than very small quantities of anything approaching the composition of a pure protein having about 16 per cent of nitrogen.

The distribution of amino acids and amino sugars in the hydrolysates of humic acid precipitates obtained from different extracts of various soils has been studied by Bremner (**17**) and the pattern appears similar to that obtained for complete soils in his earlier work. The fulvic acid fraction also contains an appreciable quantity of amino acid and amino sugar nitrogen so there is no clear cut division in the forms of nitrogen between these two fractions.

One explanation for the failure to isolate appreciable quantities of protein from soils is that, apart from the protein within the living cellular tissues, the soil protein is complexed with some other constituent and thus rendered less liable to decomposition. In the period between the two World Wars the emphasis in studies on soil organic matter changed from the chemical to the microbiological approach largely through the influence of Waksman and his associates in New Jersey. Waksman (**18**) himself compiled a monumental monograph on the subject of 'humus' in which the developments to 1938 were reviewed in great detail.

This eminent work in the English language is matched only by that of Tyurin (**19**) in Russian. Waksman and Iyer (**20**) noted the similarity of natural humic acid preparations or, as they preferred to term them, α-humus precipitates and synthetic ligno-protein complexes regarding their colloidal nature, high cation exchange capacity and resistance to microbiological decomposition.

Proximate Analysis

It was postulated that the lignin of plant tissues, being more resistant to breakdown than other plant constituents such as sugars, starch, hemi-cellulose and even holo-cellulose, became partially oxidized and persisted in the soil by forming a complex with protein largely of microbiological origin. Waksman and Stevens (**21**) estimated from their system of proximate analysis that 'humus lignin' constitutes from 35-50 per cent and 'humus protein' 30-35 per cent of soil organic matter.

Although it was suggested that such a ligno-protein complex would be formed by a condensation reaction between the free aldehyde groups of lignin and the free amino groups of proteins giving a type of Schiff's base as follows:—

$$R-CHO+R'-NH_2 \rightarrow R-CH=N-R'$$

no chemical evidence was provided to support this contention and no sample of such a ligno-protein complex was isolated either from soil or from humic acid precipitates which should include such a complex. This hypothesis of a ligno-protein humus nucleus as a major fraction of soil organic matter was widely accepted but more recent studies have cast doubt on the amount of lignin or its derivatives in soils and on the form of nitrogen associated with the lignin.

Browning Type Reaction

One objection to the use of dilute alkali solutions for extracting organic matter from soils is the possibility of hydrolysis taking place and various side reactions occurring such as condensation of amino compounds with aldehyde sugars in the so called 'browning' type of reaction. Certainly for studies on the nitrogen compounds this point must be borne in mind and the studies of Mattson and Koutler-Andersson (**22**) on the reaction of ammonia with auto-oxidized lignin make it clear that digestion with ammonia as practised by Sprengel is undesirable.

Because of this, increasing attention is being given to the extraction of soil organic matter with nearly neutral aqueous salt solutions, usually sodium salts of anions capable of forming complexes with the polyvalent metal cations such as calcium and aluminion which are normally linked with the electro-negative humus substances to give them their insolubility and flocculated condition in natural soils.

Simon (**23**), in Germany, introduced solutions of sodium oxalate and fluoride for extracting soils and then precipitated the humic acid fraction in the usual way. He emphasized that such neutral extracts, unlike alkaline extracts, do not change colour appreciably on standing and later Bremmer (**24**) showed that absorption of oxygen was very small at *p*H values around seven compared with the high rates of absorption at high *p*H values. Although less of the total organic matter is dissolved by such neutral salts and the composition

of the organic matter extracted shows some differences from that dissolved by dilute sodium hydroxide, their use has greatly extended.

Bremmer and Lees (**25**) examined the solvent power for organic nitrogen of some 18 sodium salts of organic and inorganic acids compared with 0.5 M solutions of sodium hydroxide and carbonate and found that pyrophosphate, fluoride, oxalate, citrate and tartrate were the most effective and dissolved about 10 per cent of the nitrogen at room temperature compared with about 20-25 per cent dissolved by sodium hydroxide.

Boiling Sodium Sulphite

Tinsley and Zin (**26**) employed boiling sodium sulphite solution for extraction and found that as much as 50 per cent of the total nitrogen could be dissolved from a rich meadow soil with this reagent. The *p*H of this solution after boiling with a soil is usually about eight or less so that it is high enough to encourage dispersion of the organic matter but not high enough to cause serious hydrolysis of the organic compounds.

Further, since sulphite is a reducing anion, the possibility of browning reactions occurring during hot extraction is greatly reduced. Instead of acidifyng the sulphite extract to separate humic and fulvic acid fractions in conventional manner the *p*H was adjusted to seven with acetic acid and the solution emulsified with carbon tetrachloride according to the technique of Sevag, Lackman and Smolens (**27**).

These workers found that when solutions of nucleoproteins are emulsified with chloroform, amyl alcohol being added to reduce foaming, the protein is distributed as a film on the droplets at the interface with the aqueous phase and when such an emulsion is centrifuged the droplets of heavy density are collected as a semi-solid gel containing the protein while the nucleate remains in solution in the supernatant aqueous phase.

By repeated extraction in this way, using carbon tetrachloride containing four volumes per cent of capryl alcohol a considerable bulk of 'protein' containing gel was obtained from a sulphite extract and from this a flocculent precipitate was separated with excess ethanol containing trichloracetic acid. Analysis of this material gave a nitrogen content of nearly six per cent calculated for the ash free substance, of which nearly 70 per cent was accounted for by the ninhydrin reaction as α-amino nitrogen.

However, this was far from being pure protein although the material gave a positive biuret reaction and the problem was to know with what the protein was associated. The fact that a large part of the material was resistant to hydrolysis with 6 N hydrochloric acid and that it contained over four per cent of methoxyl group strongly suggested that the material was a ligno-protein complex. A further examination of this fraction is proceeding but it should be appreciated that the yield of nitrogen in this complex was no more than one eighth of that extracted so it is not a major fraction and earlier estimates of the amount of ligno-protein in soils appear to be too high.

The main part of the organic nitrogen dissolved in the sulphite extract remained in the supernatant liquid after separating the ligno-protein gel but attempts to isolate nucleic acid from it have not yet succeeded.

Nucleic acid provides a link between the organic nitrogen and phosphorus compounds of biological interest and the study of organic phosphorus compounds in the soil is now being pursued with vigour. The subject has been reviewed recently by Black and Goring (**28**) and it has been established that four main groups of organic phosphorus compounds can occur in soils, namely sugar phosphate compounds, phospholipids, nucleic acids and inositol phosphates. The last group seems to be by far the most abundant, probably accounting for at least half of the total organic phosphorus of soils, while the first group is transitory and concerned with the metabolism of living cells.

Phospholipids

Phospholipids are generally present in small quantity only but some doubt exists regarding the amounts of nucleic acid and the most recent study reported by Adams, Bartholomew and Clark (**29**) from Iowa suggests that this fraction may account for less than two per cent of the total. One genera' feature of interest is the finding of Kaila (**30**) in Finland that for top soils the ratio of C:N:P in the organic matter is approximately 100:10:1.

One other element present in soil organic matter which is now being given more

attention than formerly is sulphur. The sulphur containing amino-acids cystine, cysteine and methionine, are normally found in small amount in protein hydrolysates, but they appear to be largely destroyed during the direct hydrolysis of soils.

However, by using the Moore and Stein method for separation of amino-acids oy elution from a column of a cation exchange resin, Sowden (**31**) claim to have identified methionine and cystine in soil hydrolysates and Bremmer (**17**) found cysteic acid and methionine sulphoxide in the hydrolysates of humic acid precipitates obtained from both sodium hydroxide and pyrophosphate extracts of soils. Much remains to be discovered regarding organic sulphur compounds, for the data of Evans and Rost (**32**) indicate that organic sulphur approximates in amount to organic phosphorus in soils.

Space does not allow the further discussion of such topics as metal organic complexes, or the problem of polyuronide compounds or the occurrence of antibiotics and plant growth substances in soil organic matter, but enough has perhaps been written to illustrate the complexity of the subject and, it is hoped, something of its practical importance and, at the same time academic fascination.

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Steel Industry Progress

IN THE 10 years since the end of the war the output of the steel industry has been increased by two-thirds. It has been a period of expansion, and on an average, £1,000,000 has been spent each week on modernization and development. Current expenditure is now about £80,000,000 a year.

In 1946, the first full peace-time year, the output of steel alloys for high quality and precision engineering was 535,000 tons, compared with an estimated output of 1,200,000 tons in 1955. Pig iron output per furnace is now 75 per cent higher than in 1945, as is the steel output per open-hearth furnace. The total steel output has averaged an annual increase of about 5¼ per cent—from below 12,000,000 tons in 1945 to nearly 20,000,000 tons in 1955.

New and modernized plants are helping the industry to use raw materials with increasing efficiency and economy; since the war fuel consumption per ton of steel has been cut by 15 per cent. The home production of steel in 1955 is estimated to be nearly 19,800,000 tons, an increase of more than 1,250,000 tons over 1954. It is expected that the output for 1956 may reach 21,000,000 tons.

SCI Summer Tour

The 1956 summer tour of the food and agriculture groups of the Society of Chemical Industry will take place in Western Germany in the first week in June. Members wishing to take part in the tour should contact Dr. R. C. Wright, Central Laboratories, United Dairies Ltd., Wood Lane, London W12.

RIC Lectures

Surface Chemistry & Archaeology

ON Thursday, 8 December, the London Section of the Royal Institute of Chemistry held a joint meeting with the Battersea Polytechnic Chemical Society at which Professor Sir Eric Rideal, F.R.S., lectured on 'Surface Chemistry'. About a hundred members and visitors were present. From the very large field of surface chemistry, Sir Eric chose the aspect with which his name is always associated—monomolecular surface films, with particular reference to the orientation of molecules and their reactions at air-water interfaces.

Monolayer Techniques

The use of monolayer techniques in studying the effect of orientation of the polar groups on the rate of hydrolysis of esters was demonstrated, using the results obtained by Alexander. The agreement between experimental values of surface moment and those derived theoretically by a vector analysis technique was remarkable. Emphasis was placed on the use of such studies for investigation of reactions between proteins and various natural products, e.g. the tanning of proteins by such substances as tannic acid, so important to the leather chemist. The importance of monolayer work for studying biological systems in which surfaces play a predominant role was amply demonstrated.

In closing his lecture the speaker stressed the enormous potentialities for further work in the biological field.

Throughout the lecture Sir Eric showed a human approach to scientific problems that those involved in systematic studies of inanimate reactions are so apt to loose sight of.

An entertaining lecture on an unlikely subject was given by Dr. H. J. Plenderleith before a joint meeting of the Royal Institute of Chemistry with the Cambridge University Chemical Society at Cambridge on 25 November. Defending his title, 'Science in the Service of Archaeology', the lecturer insisted that archaeology, though itself a science, depended upon a variety of scientific techniques. He proceeded to make his point by illustrating some methods of studying antiquities in common use at the British Museum Research Laboratories.

Efflorescence of soluble crystalline salts frequently had a destructive effect upon inscribed stone or clay, but advantage could be taken of the fact that such salts always migrated to the zone of greatest evaporation, and simple treatment with wet paper mash removed the unwanted incrustation without damage to the inscription. Disintegrating marble might be bound with calcium caseinate, and gum dammar in ethereal solution was a reliable method of preserving wood from which all the cellulose had decayed away.

Cathodic reduction might be used with remarkable success for cleaning copper and tin objects that had been long interred. Bronze relics were better treated with Rochelle salt followed by sulphuric acid, but they usually had an artificial look after such treatment; for restoring the old bronze colour nothing equalled plasticine liberally applied and removed after a few hours' contact. Ion exchange resins might be used for removing carbonate corrosion from leaden articles, the end-products being carbon dioxide and water, leaving the original lead surface unchanged.

Quite apart from chemical methods many other techniques were often brought into service. Among such were ultra-violet and infra-red photography, X-ray analysis, spectrography, pollen analysis, colorimetry, microscopy and isotope analysis.

The lecture will be repeated on Wednesday, 18 January 1956, at 6.30 p.m. at the Institute of Metals, Grosvenor Gardens, London SW1.

Investments in Sasol

IN its annual report for the year ended 30 June 1955, the Industrial Development Corporation of South Africa Ltd. states that its largest single investment is in the oil from coal plant, Sasol, and at the end of the financial year this consisted of £25,000,000 in shares and £9,500,000 in loans. The additional funds that will be required by Sasol will depend on how soon it can reach full production and earn cash from the sale of its products. In the meanwhile, despite setbacks which, although of a minor character in themselves, have resulted in serious delays, production on a limited scale has started. The importance of this project lies not only in the production of petroleum products but also in the production of raw materials for the chemical industry.

Development Programmes of the Chemical Industry in South India

(An On The Spot Survey by Our Correspondent)

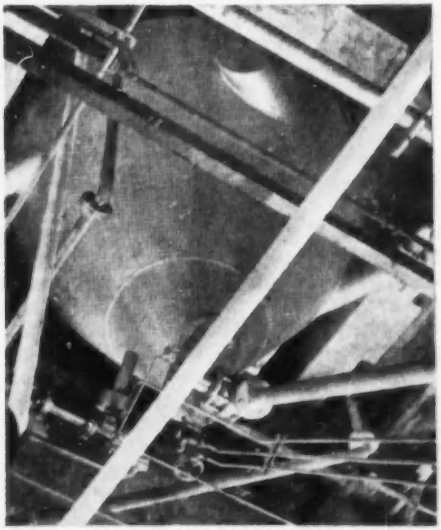
THE chemical industry in South India is well organized into a series of closely integrated and economical production units in consonance with the raw materials and sources of electric power available in this part of the country. It has become largely possible owing primarily to the enlightened foresight of the *entrepreneurs* and the support given by the State Governments of Madras and Travancore-Cochin. The chemical industry has been a pioneer in several respects in South India. It is perhaps necessary to record that units such as the Mettur Chemicals and Industrial Corporation Ltd., Mettur Dam; The Fertilisers and Chemicals Travancore Ltd., Alwaye; The Travancore-Cochin Chemicals Ltd., Alwaye; The Indian Rare Earths Ltd., Alwaye; The Travancore Titanium Products at Trivandrum and The Travancore Rayons at Perumbavoor are some of the outstanding factories in the country which are contributing abundantly to the chemical wealth of the nation.

It is also necessary to state that some significant additions to the plants have been made in the recent past, while many development programmes are in the offing to be implemented in the immediate years ahead during the Second Five Year Plan period. The projects listed above are in the private sector while the Indian Rare Earths Ltd., is in the public sector, being run as a State-owned concern. The Fertilisers and Chemicals Travancore Ltd., is jointly owned by Government and private interests.

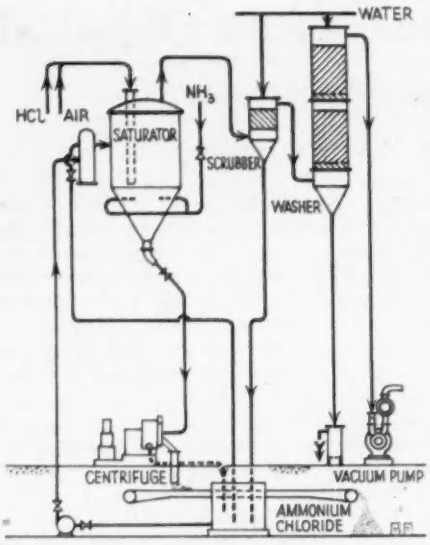
Recent Additions

Among the recent additions to plants, the pride of place should naturally go to the ammonium chloride factory of the Fertilisers and Chemicals Travancore Ltd., at Eloor, near Alwaye, Travancore-Cochin State. This factory, which was started in 1944, began commercial production of ammonium sulphate in 1948 and has since diversified its production to include superphosphates, ammonia, sulphuric acid and carbon dioxide. It began production of ammonium chloride for the first time in the country about six months back and this was made possible by the proximity of this factory to another in the region manufacturing electrolytic chlorine *viz.*, the Travancore-Cochin Chemicals Ltd., and by the close co-operation between the two in the effective utilization of by-products.

The ammonium chloride plant, having a capacity of 25 tons of salt per day, was designed and supplied by Krebs & Co., Zurich, Switzerland, though the erection and commissioning has been done locally. Ammonium chloride is produced by the straight neutralization of synthetic ammonia drawn from The Fertilisers and Chemicals Travancore Ltd., and hydrochloric acid gas from their associates, the Travancore-Cochin Chemicals Ltd. The two gases are fed continuously into two saturators where they react to form the salt. The saturators are operated under vacuum and the heat of the reaction is utilized for evaporation, causing the crystals to separate out. The



A view of the saturator in the ammonium chloride plant of FACT Ltd., Alwaye



Flowsheet of ammonium chloride process

crystals are centrifuged and bagged while the mother liquor is returned to the saturators. This plant will certainly go far to meet the needs of the country for this chemical, which has till now been imported.

A typical analysis of the product is as follows :—

Moisture	0.06 per cent
Non-volatile	0.065 per cent
NaCl	0.004 per cent
Total SO_3	Nil
Fe	0.0003 per cent
Ni	Nil
NH_4Cl	99.91 per cent

The Fertilisers and Chemicals Travancore Ltd. has currently under its active consideration a scheme of expansion to double its present capacity in respect of nitrogenous fertilizers. The scheme involves increasing the ammonia production from 40 to 80 tons per day and using the additional ammonia for the production of more ammonium sulphate and also for new products such as ammonium phosphate. It is perhaps fitting to recall at this juncture, that the existing plant is unique in that it utilizes wood for the production of ammonia. While this is the first instance in which wood has been used in ammonia manufacture, the performance of the plant over a period of years has proved that the use of wood in ammonia synthesis is an outstanding development in the field of chemical engineering.

The firewood from the forests, cut into lengths, is charged into the producers. The producer plant has six generators which are the largest of their kind in the world. The producer gas, containing about 40 per cent reducing gases, is cleaned of tar by electrostatic precipitators and stored. Hydrogen is produced by the cyclic oxidation and reduction of a hot bed of iron ore using steam and producer gas, while in the nitrogen plant the producer gas is burnt under controlled conditions in a waste heat boiler to form nitrogen and carbon dioxide ; the latter gas is separated in a Girbitol plant using an aqueous solution of mono-ethanolamine as the absorbent. The nitrogen and hydrogen are fixed at 350 atmospheres in the converters.

Future Developments

Future developments are based on electrolytic hydrogen and atmospheric nitrogen. As a result of the rapid development in the hydro-electric power generation in Travancore-Cochin State, it has now become possible to use electrolytic hydrogen for the production of ammonia. Nitrogen is to be obtained by the liquefaction of air. The synthesized ammonia will go to meet the requirements of additional ammonium sulphate production and production of newer products. The expansion proposals envisage a 50 per cent increase in the production of ammonium sulphate by direct neutralization. The sulphate plant will suitably be expanded to cover increased production.

A part of the ammonia is to be utilized for the production of 50 tons of ammonium phosphate of 16/20 grade per day. A phosphoric acid plant will also be installed for making the necessary amount of acid. In order to meet the additional requirements of sulphuric acid on account of the expanded sulphate and phosphoric acid production, it is proposed to put up an additional sulphuric acid plant with a capacity of 150 tons per day. The plant will be designed to use sulphur with specific provision to utilize pyrites at a later date. Lastly, in view of the availability in this factory of both ammonia and superphosphate, it is proposed to install machinery for the production of ammoniated superphosphate. Not only will this fix nitrogen with the least cost but will also eliminate bag-rotting which is a handicap in the storage and distribution of superphosphate. The schemes as outlined

above are of such a magnitude as to involve a tremendous capital outlay.

It is understood that the schemes are finding favour with the Government of India and the State Government, so that the company is assured of a measure of financial support. It is also learnt that some phases of the programme are in an advanced state of development and tenders have been called for plant and machinery.

The Travancore-Cochin Chemicals Ltd., Alwaye, is engaged in the manufacture of rayon grade 99.5 per cent caustic soda and the plant is the largest single unit in the country, with an installed capacity of 20 tons of rayon grade caustic soda per day. The process employed in the factory is the mercury cell process so popular in Europe. The product of manufacture is a solution of 50 per cent strength which can be used in most manufacturing industries as caustic lye. The caustic soda is also produced in part in flakes. In addition the hydrogen and chlorine produced during electrolysis are burnt together in special ovens to form about 55 tons per day of commercial high grade hydrochloric acid. Facilities also exist for the manufacture of 5,000 gallons of bleach liquor with five per cent available chlorine.

The factory is planning an expansion of the alkali production to meet growing needs. An automatic caustic pot will also be installed instead of the present intermittent one. The surplus chlorine that will then be produced will be used in the production of DDT and pvc. It may be recalled here that the first factory to manufacture DDT was set up near Delhi as a State-owned venture with a capacity of 700 tons per annum. The factory has in recent weeks been producing over a ton of the chemical per day and arrangements are being made to step up production to the installed capacity. It is proposed further to increase the plant capacity to 1,400 tons per annum for which plans have been laid.

International Co-operation

The designing of the additional equipment and plant is being completed by Indian technicians and experts lent by UN bodies, with whose assistance the plant was installed. The purchase of the machinery is now on hand. To increase the indigenous capacity for this vital chemical required urgently for health measures in India, plans have been laid for the setting up of another factory with a capacity of 1,400 tons per annum in Travancore-Cochin State.

It is anticipated that the factory will be near the site of the Travancore-Cochin Chemicals Ltd., so as to be in close proximity to the source of chlorine. It is also understood that tenders have just been received by the Government of India for the supply and setting up of the plant and are presently receiving prime consideration. The other outlet for chlorine that is contemplated, *viz.*, the production of pvc, will be a pioneer venture and the details are expected to be worked out shortly. The factory is also actively considering plans for the production of 1,000 tons per annum of hydrosulphite and an equal amount of sodium sulphide. Another scheme also engaging the attention of the industrialists is the manufacture of 10 or 20 tons per day of calcium carbide. It may be remarked that while there are three units producing carbide in India, only one is actively pursuing it near Calcutta, the other two being more in the nature of experimental measures located in South India. Thus the addition of newer products to the production schedule and the more effective utilization of by-products form the main trends in so far as this factory is concerned.

Heavy Chemicals Progress

Among other development programmes mention may be made of the fact that the construction of plant by Heavy Chemicals Ltd., near Tuticorin, is progressing well. The plant will produce five tons of caustic soda per day and will step up production to 10 tons per day gradually. The chlorine gas is to be utilized for the chlorination of ilmenite and production of titanium chlorides and titanium dioxide. An application for the expansion of the caustic soda plant of the Tata Chemicals Ltd., Mithapur, has, it is learnt, been sanctioned by the Government of India. The Company has also secured the approval of the Government for the expansion of the soda ash plant by about 40 per cent, of the bicarbonate plant by about 50 per cent and for doubling the capacity of the bromine and bromide plants. According to its chairman (Mr. J. R. D. Tata), the estimated expenditure on the developments in the next five years will aggregate to Rs 22,500,000 (£1,690,000).

The Mettur Chemical and Industrial Corporation Ltd., Mettur Dam, in South India, has well on hand the erection of a new stable bleaching powder plant which will take their total production to 6,000 tons per annum. The Travancore Titanium Products at Trivancrum which manufactures five tons per day

of anatase-type of pigment may go in for further expansion, once the product catches the Indian market. It may be remarked that the factory, which started production in 1952, had closed for some time till operations were resumed last year. The factory, however, has immediate plans to set up a sulphuric acid plant on the site, to facilitate operations and to bring down prices.

The starting of paper and pulp factories in South India is engaging the attention of the Government of India and recently a panel of experts has been constituted to help the Government in drawing up programmes for the development of the industries. The panel will assess the requirements of different varieties of paper in the next five years and recommend measures for their production. Further, pulp which is required not only for the paper but the rayon industry, will also receive attention.

A new, modern quinine factory has been set up in the Anamalais by the Government of Madras.

Lastly, the development of the mineral wealth of the country, with particular reference to the starting of industries based on them, is also engaging the attention of both the sectors.

It should be concluded that with the excellent record of the industry in South India, and with the setting up of newer chemical units to increase production and manufacture newer products, the chemical industry will be one of the basic industries contributing to the prosperity of the country in the years to come and more especially in the Second Five Year Plan period.

Fuel Element Corrosion

Visual Studies Now Possible

CORROSION of fuel elements by hot water, one of the important problems faced by designers of nuclear reactors, can be studied visually with an apparatus described by two Battelle Institute technologists on 14 December at the Engineers' Joint Council Nuclear Science and Engineering Congress in Cleveland.

The device, described in a paper written by Daniel R. Grieser and Eugene M. Simons, was developed at Battelle Institute, Columbus, Ohio, and consists of an autoclave fitted with windows for admitting light and taking photographs under conditions of rather high temperature and pressure. It is designed to allow time lapse motion pictures of a metal sample, such as a piece of clad uranium, to be taken from the instant of contact with the high temperature water until the corrosion is complete. The corrosion reaction is started by quickly surrounding the sample with preheated, pressurized water (600°F and 1,600 psi) transferred from a second autoclave.

The most important advantage of the instrument is that it provides a picture of the corrosion phenomenon while it is occurring and allows researchers to discover what would happen if the cladding of a reactor fuel element were to develop a pinhole in service. Photographs are not blurred by convection currents in water covering the glass windows because of the special design of the autoclave. Thus, picture clarity is limited primarily by the grain size of the film and the intensity of the light. This windowed autoclave, developed at Battelle, can be employed to study the influence of such variables as geometry, alloying, type of bonding, water temperature, and water impurities on corrosion rate. Quantitative values of corrosion rates can be derived from measured hydrogen evolution rates.

Commonwealth Bursaries

AMONG those who have been granted awards under The Royal Society and Nuffield Foundation Commonwealth Bursaries Scheme are Dr. A. M. Stephen, lecturer in organic chemistry in the University of Cape Town, and Mr. M. W. Tracey of the Rothamsted Experimental Station.

Dr. Stephen's grant is to enable him to work at Edinburgh from January 1956 to January 1957 on a study of carbohydrates, with emphasis on polysaccharide structure determination, and also of biochemical aspects of carbohydrate metabolism. Mr. Tracey's grant is to enable him to study methods in use, and those being developed at Melbourne, for the study of cellulose and the microbial degradation of keratin from January to December 1956.

Change of Address

On and after 16 January 1956 the north-west England and north Midlands office of Wild-Barfield Electric Furnaces will be at 1 Clarkehouse Road, Sheffield (telephone: Sheffield 62784).

The Training of the Chemical Engineer in Fuel Technology*

by F. H. GARNER, O.B.E., Ph.D., F.R.I.C., M.I.Chem.E., F.Inst.F. & R. LONG, Ph.D., A.R.I.C., M.Inst.F.

(Department of Chemical Engineering, University of Birmingham)

IN RECENT years a distinction has been made between the so-called 'primary' and 'secondary' technologies. The former is one in which the principles of one or more sciences are applied to a wide range of industries while the latter is one in which these principles are applied to one industry.

Chemical engineering is a primary technology and the subject provides an excellent training for men destined to enter any one of a wide variety of industries. This wide training should in addition enable such men to transfer readily from one industry to another and to apply their knowledge to problems of diverse types. At first sight it might seem that fuel technology is a secondary technology, but unlike other technologies in this class which deal with the development, production and utilization of materials such as textiles, plastics, rubber, ceramics, foodstuffs and so on, fuel technology occupies a special intermediate place since its ramifications are so wide.

This paper is concerned with the extent of training in fuel science and technology desirable for the chemical engineer in general, during his university course. Such a man may, of course, later decide to specialize in the science and technology of fuels but for the present we are considering his undergraduate course of study in chemical engineering.

Technologists Required

It has been suggested recently that the number of technologists required in the specialized secondary technologies is generally much smaller than for the primary technologies.

It has been pointed out, however, that fuel technologists are needed, at least as consultants, in wider fields of industrial activity (1). Dr. D. T. A. Townend (2) has considered the supply of and demand for persons with professional qualifications in fuel technology. He has pointed out that to provide and maintain the numbers suggested by Dr. G. E. Foxwell, namely, 4,000 persons engaged in fuel technology as their major activity and a further 12,000 who spend part of their time dealing with fuel matters, some 200 per annum should be trained primarily as fuel technologists, while a further 600 ought to acquire a professional mastery of fuel as well as their other technology.

Best Training

A British Commonwealth Scientific Official Conference (3) in 1950, agreed that the best training for the specialist in fuel technology is a course in chemical engineering followed by a specialized course either in fuel technology or in a subject such as gas engineering or mining engineering having a particular bearing on some aspect of fuel.

We believe that it is possible and reasonable to include in an undergraduate course rather more than the necessary minimum of fuel technology recommended by the Institution of Chemical Engineers (4). It has, in fact, been recognized by that Institution that while undue specialization should be avoided in a four-year degree course, certain institutions may desire to devote special attention to some subject such as fuel technology or oil technology.

Fuel technology is for several reasons a particularly suitable subject to be associated in this way with chemical engineering. First, the necessary basic background of science and engineering is similar for both subjects, and secondly, fuel utilization and efficiency in combustion are among the important tasks of the chemical engineer. Thirdly, a considerable number of chemical engineers in the United Kingdom eventually seek employment in some branch of the fuel industries whether this be in petroleum refining, or in the gas or coking industries. Fourthly, many firms which specialize in the design and manufacture of chemical plant also manufacture plant for the petroleum and gas industries.

The following figures taken from a table (5) giving the distribution of members, associate members and graduates of the Institution of

* *Paper presented to Institute of Fuel (Midland Section.)*

Chemical Engineers show that one in five is engaged in the fuel industries.

	Per cent
Coke ovens and by-product works ..	2.8
Mineral oil refining (mainly petroleum)	11.2
Gas	2.6
Electricity	0.7
Coal	1.8
Ministry of Fuel and Power	0.6
Total	19.7

It is interesting to note that several of the chemical engineering schools in British universities have developed from more specialized schools of fuel, or petroleum technology or gas engineering. There is, naturally, a traditional interest in certain facets of fuel science in these schools today and valuable work is being carried out. This represents a satisfactory state of affairs for it would be most undesirable if all universities were to turn out chemical engineers to a standard pattern.

Increased Competition

A word of warning to those interested in the future supply of fuel technologists may not be out of place here. There is no doubt that in the future such technologies as biological and nuclear engineering will take their place in chemical engineering schools alongside such current specialities as fuel technology, combustion, ceramics and refractories, low temperature technology and the like. This will inevitably mean increased competition for the very restricted supply of well-trained men of high ability. At the present time the majority of undergraduate students in chemical engineering show a marked reluctance to enter the older fuel industries. They undoubtedly prefer the newer, cleaner and perhaps better-publicized industries which, incidentally, offer on the whole better social and welfare facilities and higher starting salaries.

Comparatively few Birmingham graduates in chemical engineering seek careers on the coal utilization side of the fuel industries. It appears that it is in this field that the shortage of university trained men is most acute and likely to become more so.

The Birmingham degree course in chemical engineering is based on former separate courses which were offered in petroleum refining and in coal utilization. The Department was founded in 1922 and the student population has grown from below 20 in the last of the war years to around 200 and the teaching staff from three to 14. At the present time the maximum intake of students in chemical engineering is about 50 per annum, but in the near future when the new building now in course of construction is completed, this number will be increased to 60 per annum.

The course in chemical engineering is a four year one but most entering students are exempted from the first year by virtue of the standard reached in the GCE (advanced level) examination. The first year subjects are chemistry, physics, mathematics, descriptive mechanical engineering (and workshop processes) and engineering drawing. In the second year most time is devoted to the study of chemistry (inorganic, organic and physical chemistry including thermodynamics) together with mathematics, but in addition some time is given to mechanical and electrical engineering and fuel technology.

The third year is devoted mainly to civil, mechanical, electrical and chemical engineering. The latter includes a study of the principles underlying the unit operations and a course in stoichiometry and thermodynamics. Fuel Technology is continued, both petroleum refining and coal utilization being dealt with in separate courses of lectures. Practical work in chemical engineering is carried out partly in the well-equipped chemical engineering laboratory and partly by means of a vacation course at Easter in local works under the supervision of lecturers in the department, and a summer vacation course at the end of the session.

Design Project

The final year is devoted almost wholly to chemical engineering which, in addition to lectures and tutorial classes, includes a thesis and design project. The course work in addition to the principles underlying such unit operations as distillation, gas absorption, fluid flow and heat transfer also includes plant design, instrumentation and corrosion. In this final year chemical engineering thermodynamics is continued, short courses are taken on water chemistry and hydrocarbon chemistry and on flame and combustion. A student may choose an additional subject from petroleum refining, fuel technology, and industrial chemistry, but the amount of time which he spends on this speciality is very small compared to that devoted to his major subjects.

An important feature of the course is that much time is devoted to tutorial classes in which sets of problems are solved. Laboratory classes include experiments to illustrate the principal unit operations and in fuel technology, standard tests on solid, liquid and gaseous fuels are carried out.

The following details will, perhaps, give a better idea of the content of the courses given within the chemical engineering department. It can be seen that the training in chemical engineering is thorough and that undue specialization is avoided.

Second Year

C.E. 2.1. Fuel Technology ; origin and properties of crude petroleum ; gasoline and fuel requirements of spark ignition engines ; kerosines, illuminating and tractor ; Diesel fuels and fuel requirements for compression ignition engines and jet turbines ; fuel oils and their combustion ; coal, its origin and formation, preparation and utilization. Introduction to chemical engineering principles.

C.E. 2.2. Laboratory tests on petroleum, coal, and their solids and liquid products.

Third Year

C.E. 3.1. Chemical Engineering Principles; fluid flow, heat transfer, mass transfer ; diffusion, evaporation ; distillation ; gas absorption ; humidity, psychrometry, air conditioning, water cooling ; drying ; crushing, grinding and size separation.

C.E. 3.2. Industrial stoichiometry and thermodynamics.

C.E. 3.3. Petroleum Refining—sulphuric acid and alkali manufacture ; adsorption and extraction, application of adsorption processes and liquid-liquid extraction ; Azeotropic and extractive distillation.

C.E. 3.4. Origin and formation of coal, classification of coals, coal chemistry, types of coal, selection of coals, coal cleaning and preparation, storage of coal. Principles of combustion and gasification, air requirement, stoking and boiler operation, low and high temperature carbonization, Producer gas, water gas and synthesis gases. Gasification in oxygen and steam ; Lurgi and Winkler processes. Underground gasification. Oil gasification. Methanol synthesis. Hydrogen manufacture, Fischer-Tropsch process. Refractory and insulating materials ; brief survey of properties and uses.

C.E. 3.5. Chemical engineering laboratory.

C.E. 3.6. Instrumentation.

Fourth Year

C.E. 4.1. Fluid flow ; theories of energy, momentum and viscosity. Theory of models and dimensional analysis. Thermal conduction and heat transfer in fluids. Diffusional processes ; gas and liquid diffusivities, mass transfer coefficients ; diffusion from bubbles and droplets ; stage efficiencies, height of transfer unit. Distillation, absorption, liquid-liquid extraction, adsorption, equilibrium relationships.

C.E. 4.2. Materials of construction, corrosion, fabrication methods, plant costs etc. Instrumentation.

C.E. 4.3. Design problem.

C.E. 4.4. Flame and Combustion ; hydrocarbon oxidation and combustion, chain reactions ; Limits of inflammability, flame propagation, ignition in gas-air mixtures, flame movements—explosion ; mist and dust explosions, explosion hazards in industry, flameproof enclosure, explosion venting. Structure and stability of flames, burning velocity, flame propagation theories. Heat transfer by radiation, radiation laws. Furnaces and fuel economy, furnace types, heat balances, heat recovery, design elements.

C.E. 4.5. (Optional subject.) Reaction of hydrocarbons ; thermal and catalytic cracking of hydrocarbons, polymerization, alkylation and isomerization. Manufacture of synthetic fibres, rubbers and plastics.

C.E. 4.6. (Optional subject.) Pressure-volume-temperature relationships of hydrocarbons with reference to deviations from the ideal gas laws. The application of these relationships to petroleum reservoir engineering and to distillation under pressure.

C.E. 4.7. (Optional subject.) Combustion of solid fuels, reactions in fuel beds, gasification reactions. High temperature carbonization of coal. Nature and properties of products of coal carbonization, e.g., gas, coke, coal-tar, crude benzole, liquor. Gas purification ; condensation, tar extraction, ammonia removal, theory of multi-stage washers, ammoniacal liquor and effluents from gas-works and coke oven plants ; removal of hydrogen sulphide, benzole extraction, removal or organic sulphur compounds from gas. Coal chemistry ; physical and chemical properties, minor constituents of coal, coal as a chemical material.

C.E. 4.8. (Optional subject.) Industrial chemical processes.

C.E. 4.11. Thermodynamics and kinetics. Thermodynamics of real substances, equations of state, heat capacity data, compressibility factors. Calculation of thermodynamic properties, tabular and graphical presentation of thermodynamic properties. Phase equilibria, particularly vapour-liquid equilibria. Chemical equilibria, homogeneous and heterogeneous reactions, estimation of thermodynamic data.

Introduction to reaction kinetics, including catalytic reactions and the theory of rate processes.

Vacation Courses

Vacation courses constitute an important part of the undergraduate training and while during the long vacations our students are widely scattered at home and abroad, spending some six weeks on chemical engineering work, one course at Easter in the third year is spent in the Birmingham area. This 'Easter vacation course' is particularly important from the point of view of training in fuel technology. It is held during the last week of the Spring term and the first week of the Easter vacation and is supervised by members of the teaching staff.

Groups of four students carry out an investigation into the operation of some item of works plant such as a pipe-still, distillation column, heat exchanger or boiler plant. Many of the problems selected involve heat and material balances and provide the student with an excellent opportunity not only of practising stoichiometry but also of realizing, perhaps for the first time, that many industrial plants are not liberally provided with a multiplicity of instruments to record the flow of entering and leaving streams of energy or material.

A number of local firms have co-operated in this annual programme and this has ensured its success.

Each group of students is required to write (and present before fellow students and members of the staff during the following term) a report summarizing the nature of the problem and the results obtained.

The titles of some of these reports will indicate the type of problem encountered by these third year students: A Study of a Cooling Tower; The Efficiency of an Electro-detarrer; Materials of Construction used in Acid Plants; Study of a Condenser Operating on a Crude Naphtha Still; The Efficiency of a Pipe-still Furnace; Removal of Residual Alkalinity from Crude Cresols; Heat Balance on a Test-setting of Continuous Vertical Retorts; Tests on a Down-Jet Furnace; Boiler Trial on Coke-Breeze Fired Boilers; Operation and Control of Thyssen-Lenze Tower Purifiers; Gas Producer Test; Tests on Crude Benzole Distillation Unit; Tests on a Gas Producer and Lime Kiln; Heat and Material Balance on Quadruple Effect Salt Evaporating Unit; Heat and Material Balance on an Ammonium Sulphate Crystal Cooler; Heat and Material Balance on an Acetone Cracking Plant.

These tests were carried out through the co-operation of the following firms, to whom the authors are grateful for the facilities offered:—West Midlands Gas Board; Midland Tar Distillers Ltd.; Courtaulds Ltd.; Brothertons Ltd.; Imperial Chemical Industries (Salt Division) Ltd.; John and E. Sturge Ltd.

Thesis

In the first term of the final year all students are required to present a thesis, or perhaps more accurately a dissertation, on some topic selected by a member of the teaching staff. These are critical surveys of the literature and are presented in an abbreviated form before the class for discussion. The aim is to introduce the student to the technique of searching the library for information and presenting this in a well-ordered and well-written form. The topics are drawn from a wide field of chemical engineering, physical chemistry and technology; topics within the field of fuel technology are included.

Design Problem

The design problem is of importance in the training of chemical engineers as it requires the use of much of the knowledge, both theoretical and technological, of the course. Usually about four students work together under the supervision of a lecturer but each student submits his own report and drawings. Each report is independent and includes special features peculiar to each student's treatment.

The subjects of the design problem usually appertain to the chemical industry but topics within the field of fuel technology occur occasionally.

It can be seen from the above description of a typical degree course that the students carry a heavy load. It is, perhaps, surprising that so many of them find time to take part in the variety of interests which a university offers. Nevertheless they do, and the chemical engineering department at Birmingham is well represented in all student activities, social, cultural and athletic.

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Canadian Ammonia Plant

CIL Prepare for Increased Demand

SOME of the reasons for the decision of Canadian Industries Ltd. to construct plant for the manufacture of anhydrous ammonia at Millhaven, Ontario, are described in a paper by Mr. E. C. Brown and Mrs. A. R. Stewart, of the company's development department. Work is under way and construction of the plant is expected to be complete next summer.

Dealing with developments in the manufacture and consumption of ammonia in Canada, they state that 'nitrogen compounds constitute one of the most important groups of materials used in the chemical process industries. Most of the important nitrogen compounds are now derived from synthetic ammonia, so that in reviewing the ammonia picture one is really looking at the keystone of the nitrogen family of industrial chemicals.

'As so-called fixed nitrogen, its compounds with other elements are used in the manufacture of such large-volume end products as fertilizers, explosives, plastics, synthetic fibres, uranium, nickel, cracking catalysts, paper and refrigerants'.

Stating that world use of ammonia had more than doubled since 1947 when 3,200,000 tons were consumed, the article declares that 'the post-war increase in Canadian consumption of ammonia, particularly in the East, has been due largely to the steadily expanding requirements for explosives and fertilizers. The rate of growth has increased sharply in the last few years with the development of several new outlets for ammonia, and these new factors are expected to cause the upward trend to continue.

Important Outlets

'The most important new outlets for ammonia are not strictly in the chemical industry, but in the closely related fields of metallurgy and pulp manufacture. New developments in the manufacture of sulphite pulp are expected to bring the largest increase in the demand for ammonia in Eastern Canada. The advantages to be gained by using anhydrous ammonia instead of limestone in the sulphite process are being evaluated carefully by pulp manufacturers, and four Canadian mills have already made the change to ammonia.

'There are more than 40 sulphite mills in Eastern Canada, representing a potential market for at least 100,000 tons per year of ammonia', the experts state. 'Many of the mills are so situated that the use of ammonia is not attractive to them at present, but it is forecast that by 1965 over a third of the mills will have converted to ammonia. This will make the pulp industry the largest industrial outlet for anhydrous ammonia in Eastern Canada.

Increased Consumption Expected

'It is expected that the consumption of ammonia and ammonium compounds in fertilizers in Eastern Canada will increase by over 150 per cent in the next ten years.

'The direct application of anhydrous ammonia to the soil is a relatively new development. Direct application is at present only in the experimental stage in Canada, but it is expected to grow in popularity during the next few years in those areas where it can be used.

'The increasing availability of ammonia at prices which have steadily decreased in relation to those of other chemicals has been due to the joint efforts of chemists who have devised new processes and engineers who have simplified and reduced the cost of the equipment required to operate at such pressures', say Mr. Brown and Mrs. Stewart.

Referring to ammonia leaching, the experts state that 'in the metallurgical field a new ammonia leaching process for the extraction and recovery of base metals was developed by Sherritt Gordon Mines Ltd. and Chemical Construction Corporation. The ammonia used to treat the ore concentrates ends up as ammonium sulphate and the sale of this by-product is important in establishing the economics of the process. The leaching method is reported to be suitable for use with a number of Eastern Canadian ores, but the limited market for ammonium sulphate in the East is a stumbling block to the adoption of the process. While it is difficult to

forecast how extensively ammonia leaching will replace conventional smelting methods, even a few applications would have very large requirements for ammonia. Probably the outlook is best for metal refineries located at tide water and able to ship economically to export markets.

'Other metallurgical operations which will consume appreciable quantities of ammonia are a new process to recover nickel from pyrrohotite and the treatment of uranium concentrates which requires nitric acid made from ammonia'.

'Super Film'

'The World that Nature Forgot'

A SHORT time ago some 250 representatives of the British plastics industry, together with Press representatives and other people interested in the use of the film as an advertising and/or educational medium, attended a private showing of 'The World that Nature Forgot' at Claridge's, London. The showing was arranged by Monsanto Chemicals Limited by whose American parent company the film was made.

It is unusual for a Public Relations Officer to understate the position but when Mr. W. D. Garner wrote to invite us to see the film he merely said that it was well above average. Without a doubt 'The World that Nature Forgot' is the finest commercial film we have seen and Mr. Garner could have been forgiven if he had used some of those superlatives for which film publicity officers are notorious. Certainly we have never heard such effective background music in any British commercial film and it was pleasing to know that it had been written by Benjamin Frankel and recorded by the London Philharmonic Orchestra. Nor have we ever seen such a 'heavy subject' treated in such a way that it could completely hold the interest for the entire length of the film. At most showings of such films the audience yawns and squirms continually while waiting restlessly for the lights to come on, but on this occasion at least one member of the audience was sorry to see 'The End' flash on the screen.

The film opens with scenes illustrating how Nature uses photosynthesis to combine molecules to produce food, fibres and such 'natural plastics' as tree-grown rubber. The picture then takes the audience into the invisible world of atoms and molecules and shows how man has learned to join these to form materials not found in Nature.

A 'molecule ballet' follows, in which molecules of ethylene, benzene and chlorine are shown combining to form styrene and vinyl polymers in the presence of heat, pressure and catalysts. The achievement of this sequence required the development of unique apparatus in a specially constructed studio of Halas and Batchelor Cartoon Films Limited, London. Stop motion photography, black light and special optical equipment were among the techniques employed.

Subsequent scenes, taken at various Monsanto plants in the US, show how basic resins are converted into films, crystals and powders which are turned by moulders and fabricators into durable plastic products.

Two years were required by MPO Productions Inc. of New York to make 'The World that Nature Forgot'. The script was written by Robert Campbell, an editor of LIFE magazine, and the narrator is Westbrook Van Voorhis, noted for his seventeen years as narrator with the film series 'Time Marches On'.

Monsanto hope to obtain soon additional copies of the film for showing in the UK. We strongly advise anyone who is in any way interested in industrial films to make an effort to see 'The World that Nature Forgot' at the earliest possible moment.—E.A.R.

Solvent Oil Plant

A new plant for the continuous extraction of solvent oil from nuts is to be added to the existing plant of the Shemen factory near Haifa, it is announced. The new plant will be able to extract twice as much oil as the existing one, which, in three shifts, processes 75 tons of oil daily. Purchased through the reparations agreement, the plant has cost $300,000 and will cost another I£1,000,000 to install.

Northern Council Discussion

One of the main subjects to be discussed when the Northern Council—consisting of Members of Parliament of Denmark, Iceland, Norway, Sweden and Finland—meets in Copenhagen at the end of January, will be atomic co-operation. A report has been prepared by Mr. Gunnar Randers, director of the Norwegian Atomic Energy Authority.

Solutions of Cellulose Derivatives

by W. R. MOORE, B.Sc., Ph.D., F.R.I.C.

(Department of Chemistry & Dyeing, Technical College, Bradford)

IN recent years knowledge of the properties of solutions of cellulose derivatives has been considerably extended and, with the help of modern theories of high polymer-solvent interaction, it is possible to present a qualitative account of the principles governing these properties and to obtain closer insight into the mechanism of cellulose derivative-solvent interaction. The chief factors which determine whether a particular cellulose derivative will dissolve in a given liquid appear to be the structure and degree of substitution of the derivative, the chemical type of the liquid and certain of its properties. The effects of structure and degree of substitution have been discussed by Howlett and Urquhart (**1**).

In this review we shall be concerned with the requirements of solvents for cellulose derivatives, the evaluation of solvent power and the viscosities of dilute solutions. Consideration will be largely restricted to derivatives of commercial interest and fairly high degree of substitution such as cellulose nitrates with N contents between 11 and 14 per cent, primary and secondary cellulose acetates and ethyl cellulose with ethoxyl content between 48 and 50 per cent.

Free Energy Decrease

For solution to occur there must be a decrease in the free energy of the solvent-solute system as a whole. The change in free energy, ΔG, is given by

$$\Delta G = \Delta H - T\Delta S$$

where ΔH is the heat content change, ΔS the entropy change and T the absolute temperature. There is always an entropy increase (ΔS positive) when solution occurs. If polymer and solvent mix without heat change or with small heat absorption (ΔH positive) ΔG will be negative and solution will occur. ΔH is the sum of the amounts of heat concerned in breaking polymer-polymer and solvent-solvent bonds and in making polymer-solvent bonds. In cellulose derivatives polymer-polymer bonds are often strong and the energy absorbed in breaking them is large. If ΔH is not to have a large positive value, heat must be evolved in forming polymer-solvent bonds. This means that solvation, strong specific interaction between functional groups of derivative and solvent, must occur.

Evidence for Solvation

The functional groups of cellulose derivatives are unsubstituted hydroxyl, inorganic or organic ester, and ether groups. Evidence for solvation of such groups in cellulose acetate has been discussed in recent papers (**1**, **2**, **3**). Infra-red absorption, freezing point and dielectric studies suggest hydrogen bonding between acetate groups and phenols, aniline and chlorinated hydrocarbons. Calorimetric and swelling studies support such suggestions. Infra-red absorption results suggest that alcohols, acetone, dioxan and heterocyclic bases may interact strongly with hydroxyl groups.

The solvation of cellulose nitrates has been discussed in a recent book by Miles (**4**). There is calorimetric evidence for solvation of the nitrate group by ketones and esters, supported by the results of sorption and other experiments. There is less evidence for solvation of the more weakly polar ether groups and the solubility of some ethyl celluloses in non-polar solvents such as benzene and carbon tetrachloride suggests that solvation is not always necessary. The decreased solubility of certain methyl celluloses in water on heating may be due to decreased hydration.

The number of solvent molecules bound to each functional group of a derivative is doubtful. Calorimetric and other studies suggest two to six solvent molecules per glucose unit of cellulose acetate or nitrate. Experiments using simpler substances as

models for cellulose acetate suggest that one or two solvent molecules may be bound to each acetyl group. Larger numbers, ranging from seven to 19 per glucose unit, have been suggested. Firm binding of such large numbers seems unlikely but some attraction propagated by a first solvation layer is possible.

Solvents for cellulose derivatives must not only contain groups capable of solvating polymer groups but must also be able to dissolve the solvated derivative. A different solvated polymer will correspond to each solvent although differences between polymers resulting from solvation of a derivative by similar solvents may not be great. Solvated polymer and solvent are likely to mix with absorption of heat. According to theories of polymer-solvent interaction the heat absorbed may be proportional to $V_1(\delta_1 - \delta_2)^2$ where V_1 is the molar volume of the solvent and δ_1 and δ_2 are the 'solubility parameters' of solvent and polymer. δ is equal to $[(L_v - RT)/V]^{\frac{1}{2}}$ where L_v is the molar latent heat of vaporization and V the molar volume, both at the absolute temperature T.

Acid-Base Interaction

If ΔG is still to be negative the amount of heat absorbed in mixing solvated polymer and solvent must not be too large. This restriction means that δ_1 and δ_2 must not be very different. Spurlin (**5**) regarding solvation as acid-base interaction in the generalized Lewis sense, says that solvents must not only be basic or acidic in character but must also have an appropriate δ value. This appears to be the case with secondary cellulose acetate (**6**) which is soluble in liquids of correct type whose δ values lie between about 9.5 and 12.5. Cellulose nitrates are soluble in ketones and esters with δ values between about eight and 10.5. Solvents for ethyl cellulose of about 48 per cent ethoxyl content have δ values between about eight and 10.5. Liquids of correct type for solvation but with δ values outside these limits will only swell the derivative.

Such considerations help to explain the solubility of some cellulose derivatives in mixtures of non-solvents. Secondary cellulose acetate is only swollen by ethyl acetate although it is presumably of correct type for solvation. Addition of ethanol, also a non-solvent, causes solution. The solubility parameter of ethyl acetate is 9.1 at 20°C, that of ethanol being about 13. A mixture of the two will have a solubility parameter within the range required for solution of the solvated polymer. The well known solvent properties of ether-alcohol mixtures for certain cellulose nitrates may be explained similarly.

Unlike that for substances of small molecular weight, the solvent power of solvents for cellulose derivatives cannot usually be stated in terms of saturation solubility. Continued addition to a pure solvent leads to formation of a gel, the physical characteristics of which, not saturation, prevent further solution. Technically, solvent power is often assessed in terms of the volume of non-solvent liquid which, when added to a solution of fixed concentration, just causes turbidity. The ratio of this volume to that of the original solution is called the 'dilution ratio'. The greater its value the better is the solvent power of the solvent assumed to be.

Although this method gives useful information regarding diluent tolerance it has disadvantages as a method of estimating solvent power in a thermodynamic sense. The dilution ratio varies with the non-solvent used, being greater with aromatic than with aliphatic hydrocarbons. Different non-solvents may give different orders of solvent power when a number of solvents are compared (**7**).

Osmotic Pressure

For high polymer-solvent systems generally the Huggins interaction parameter μ (**8**) is a convenient measure of solvent power. It is related to ΔG, the free energy change in solution, and it decreases with increasing solvent power. If μ is greater than about 0.5 solution does not occur. It is perhaps most conveniently obtained from the results of osmotic pressure measurements on dilute solutions. If the ratio of osmotic pressure to concentration is plotted against concentration a straight line is usually obtained the slope of which is equal to $RT(\frac{1}{2} - \mu)/V_1 d_2^2$ where R is the gas constant, V_1 the molar volume of solvent and d_2 the polymer density. Values of μ for cellulose derivative-solvent systems have recently been obtained in this way (**9, 10**) and may be used to determine to what extent dilution ratios are related to solvent power in a thermodynamic sense.

Table 1 gives values of μ for cellulose

TABLE I

Solvent	Cellulose nitrate 12.5 per cent N			Cellulose acetate 53.7 per cent acetic acid yield			Ethyl 48.2 per cent ethoxyl	
	μ	D R hexane	D R toluene	μ	D R hexane	D R toluene	μ	D R hexane
acetone	0.27	0.8	7.1	0.45	0.08	0.37	0.46	2.3
ethyl methyl ketone	0.21	0.9	6.2	—	—	—	0.42	1.85
n-propyl methyl ketone	0.15	1.13	5.9	—	—	—	0.37	1.4
n-amyl methyl ketone	0.02	1.4	4.7	—	—	—	0.38	0.8
methyl acetate	0.30	0.76	2.9	0.45	0.05	0.12	0.41	2.25
ethyl acetate	0.22	1.15	3.6	—	—	—	0.39	1.7
n-propyl acetate	0.13	1.37	3.5	—	—	—	0.33	1.5
n-butyl acetate	0.015	1.51	3.2	—	—	—	0.24	1.4
n-amyl acetate	0.02	1.44	2.7	—	—	—	0.28	1.0
chloroform	—	—	—	—	—	—	0.34	4.0
benzene	—	—	—	—	—	—	0.46	0.45
toluene	—	—	—	—	—	—	0.48	0.25
carbon tetrachloride	—	—	—	—	—	—	0.47	0.15
aniline	—	—	—	0.38	—	1.20	—	—
nitromethane	—	—	—	0.44	—	0.26	—	—
pyridine	—	—	—	0.28	0.41	1.31	—	—
α-picoline	—	—	—	0.36	0.22	0.62	—	—
β-picoline	—	—	—	0.29	0.39	1.17	—	—
γ-picoline	—	—	—	0.26	0.42	1.35	—	—
dioxan	—	—	—	0.38	0.14	0.27	—	—

nitrate-, cellulose acetate- and ethyl cellulose-solvent systems at 25°C together with dilution ratios obtained with one per cent solutions at the same temperature, using hexane and toluene as diluents. In the case of cellulose acetate, although the hexane dilution ratios are less than those for toluene, both decrease as μ increases and give the right order of solvent power. This seems to be roughly true of the hexane dilution ratios for the cellulose nitrate solutions but the toluene ratios give quite different orders of solvent power in each of the two homologous series of solvents. The hexane dilution ratios for ethyl cellulose solutions in polar solvents tend to decrease as μ decreases and are clearly not a measure of solvent power although the poor non-polar solvents have low dilution ratios.

The reasons for such differences are not entirely clear but at least two factors may be important. Polymer-solvent interaction theory suggests that, under certain circumstances, the greater the difference between the δ values of solvent and polymer the poorer the solvent and the smaller the volume of precipitant required. The dilution ratio will, however, only give the correct order of solvent power if the δ values of the precipitant and of the solvents to be compared all lie on one side of that of the polymer (**11**). The matter is further complicated, with cellulose derivatives, by the possibility of precipitation of solvated polymer. Estimates of δ values for such polymers are not easy but it seems likely that the values for cellulose acetate are above those for most solvents and for hexane (7.4) and toluene (8.9). Similar conditions may apply when hexane is used as precipitant for the cellulose nitrate.

In the case of the ethyl cellulose the δ values for the polymers separating from polar solvents may be less than those for the lower members of the two series but above those for higher members. Addition of hexane to lower members would enhance solvent power. The toluene dilution ratios for cellulose nitrate solutions are less easy to interpret. There is evidence that aromatic hydrocarbons may solvate cellulose nitrate and they may also interact with such polar solvents as ketones. In such circumstances it is difficult to predict how dilution ratios will vary with solvent power. Precipitants used in the assessment of solvent power by the dilution ratio method should not themselves interact with cellulose derivatives and non-polar aliphatic hydrocarbons are to be preferred. It would seem that if the precipitant is carefully chosen the dilution ratio method will give the correct order of solvent power, in a thermodynamic sense, for some cellulose derivatives.

The viscosity of a solution of a cellulose derivative, at a given temperature, depends on the viscosity of the solvent, the concentration, molecular weight and degree of substitution of the derivative and on its interaction with the solvent. In order to eliminate solvent viscosity it is convenient to use the 'specific viscosity', η_{sp}, defined by

$$\eta_{sp} = (\eta - \eta_o)/\eta_o$$

where η is the viscosity of the solution and η_o that of the pure solvent. The variation of η_{sp} with concentration c can be expressed

in a number of ways most of which can be reduced to

$$\eta_{sp}/c = [\eta] + Bc + Cc^2$$

where B and C are constants for a particular derivative and solvent and $[\eta]$, the 'intrinsic viscosity' or 'limiting viscosity number', is an important quantity being related to the shape of the polymer chains in solution and to their molecular weight. $[\eta]$ can be obtained by extrapolating η_{sp}/c to zero concentration. Various methods of extrapolation have been suggested (**12, 13**), one of the commonest involving extrapolation of a linear plot of log (η_{sp}/c) against c. Roseveare and Poore (**14**) and Harland (**15**) have recently suggested methods by which $[\eta]$ can be obtained from measurements at one concentration.

Staudinger Expression

The variation of $[\eta]$ with molecular weight M of polymer may be expressed by

$$[\eta] = KM^a$$

where K and 'a' are constants for a given polymer, solvent and temperature. The Staudinger expression $[\eta] = KM$ is a special case of this with 'a' = 1. The expression provides a basis for a rapid method of determining M, a knowledge of which is important in many branches of cellulose technology since such properties as surface coverage, fibre or film formation and strength, and others depend on molecular weight or chain length. In order to obtain values of K and 'a' for a given derivative and solvent, samples of known M are required.

Cellulose derivatives are heterogeneous as regards chain length and more homogeneous samples of differing molecular weight are usually obtained by fractionation, methods for which have been reviewed by Conrad (**16**). Roseveare and Poore (**17**) and Harland (**18**) have discussed the fractionation of nitrated rayons and Scott (**19**) has reviewed the theory of fractionation. Precipitation of fractions by stepwise addition of precipitant to dilute solutions, followed by refractionation, appears to be the most efficient method.

Molecular Weights

Molecular weights of fractions are obtained by osmotic, light scattering or ultracentrifuge methods. It is desirable that the fractions be as 'sharp' as possible as different average molecular weights are obtained by different methods. Given sharp fractions it is only necessary to obtain values of $[\eta]$ for each fraction in the chosen solvent. A logarithmic plot of $[\eta]$ against M gives a straight line the slope of which equals 'a' and the intercept K.

This method has recently found considerable application in the determination of the molecular weight of cellulose. Few liquids are capable of dissolving cellulose and those that do may cause degradation. Cellulose may be nitrated without degradation to a trinitrate which is soluble in a wide range of solvents for which K and 'a' values may be obtained. Immergut, Ranby and Mark (**20**) have obtained values at 25°C for acetone, ethyl acetate and ethyl lactate, using a wide range of commercial cellulose samples with molecular weights varying from 27,000 to 900,000. Newman, Loeb and Conrad (**21**) have used commercial celluloses and ethyl acetate as solvent. Harland (**15, 18**) has used the method to study molecular weight distribution in rayons. Mitchell (**22**) has described a tentative standard method for nitration, fractionation and viscosity measurement. The method does not seem to have been very widely used to obtain molecular weights of other derivatives but values of K and 'a' have been obtained for lower N content nitrates and for secondary cellulose acetate. The following table gives representative values.

TABLE 2
K and a values at 25°

Derivative	*Solvent*	$K \times 10^4$	*a*
trinitrate	acetone ..	1.1	0.91
trinitrate	ethyl acetate	0.38	1.03
trinitrate	ethyl lactate	1.22	0.92
dinitrate	acetone ..	1.91	0.79
secondary acetate ..	acetone ..	1.49	0.82

The value of $[\eta]$ increases with increasing degree of nitration of cellulose nitrate. The increase, which may be due to increased solvation or greater extension of chains, varies with the molecular weight and N content range covered. Lindsley and Frank (**23**) have given an equation by which a value of $[\eta]$, independent of N content, may be calculated. In the case of cellulose acetate increasing degree of substitution may lead to a decrease in $[\eta]$. Thus non-degradative acetylation of a secondary acetate to the triacetate caused the intrinsic viscosity in *m*-cresol to fall from 1.82 to 1.15 (**2**).

The dependence of the viscosities of dilute solutions of cellulose derivatives on the solvent is rather complex. For flexible polymers, such as polystyrene, $[\eta]$ increases

with solvent power, and the variation of η_{sp} with c can be expressed by

$$\eta_{sp}/c = [\eta] + k[\eta]^2c$$

k decreasing with increasing solvent power. This latter relationship does not seem to be generally applicable to cellulose acetate (**2,6**) or nitrate (**10, 13**). Spurlin (**5**) has suggested that the slope of the plot of $\log(\eta_{sp}/c)$ against c, divided by $[\eta]$, varies in a similar way with solvent power for cellulose derivatives but this is not generally true (**6, 10, 13**). Cellulose derivatives have only limited chain flexibility and since $[\eta]$ is related to the shape of the chains in solution its variation with solvent is much less than that for flexible polymers. The exponent 'a' in the expression $[\eta] = KM^a$ is a measure of chain extension, varying from 0.5 for tightly coiled chains to unity or more for extended configurations, and the relatively high values given in Table 2 reflect the stiffness of the chains.

Variation Possible

However, some variation of chain extension with solvent is possible and the values of $[\eta]$ for cellulose nitrate (**10**) and ethyl cellulose, in a homologous series of solvents, tend to increase with solvent power as do the initial slopes of η_{sp}/c against c plots. Association of polymer in poor solvents may, however, lead to high slopes and values of $[\eta]$. The restriction of such relationships to a homologous series of solvents shows the importance of solvent type.

This is particularly evident with secondary cellulose acetate. Solvents capable of bonding with acetyl groups give higher values of $[\eta]$ than those which may bond with hydroxyl groups of the polymer (**6**). This has been interpreted (**2**) in terms of intra-molecular hydrogen bonding between acetyl and hydroxyl groups which stiffens the chains. Solvation of hydroxyl groups will break such bonds permitting less extended configurations and lower values of $[\eta]$. Solvation of acetyl groups will not break such bonds but further acetylation, removing hydroxyl groups, leads to less extension of chains, explaining the reduction of $[\eta]$ with increasing degree of substitution.

Attempts have been made to apply recent hydrodynamic theories of polymer solution viscosity to solutions of cellulose derivatives. The results have been reviewed by Immergut and Eirich (**24**). Although questions regarding the stiffness and extension of the chains are not completely answered it appears that at low degrees of polymerization the chains behave as rods. At degrees of polymerization between 400 and 600 the chains are somewhat coiled. At higher degrees the flexibility may be such as to permit the application of the more recent theories of Flory (**25**). Interest has also been shown in the properties of solutions of polyelectrolytic cellulose derivatives and papers dealing with solutions of cellulose xanthates (**26**), carboxymethylcellulose (**27, 28**) and potassium cellulose sulphate (**29**) have appeared. This field seems likely to develop in the future.

Broad Features Clear

Although many questions regarding the interaction of cellulose derivatives and solvents remain to be solved the broad features seem fairly clear. If solvation and the limited flexibility of the chains are taken into account many solution properties seem capable of interpretation in terms of modern theories of polymer-solvent interaction.

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Chemical Shares in 1955

by J. F. REID

THE past year in stock markets contrasted sharply with 1954 which was a period of strongly rising prices, particularly in industrial shares. In 1955 it seemed at the outset that the buoyant trend would continue unabated, but it soon became apparent that inflation was a danger, and that if it went unchecked it would hit our export trade severely. The April Budget with its cut in income tax created an excellent impression in stock markets, as did the result of the General Election, but there were many signs that inflation dangers were increasing, and abroad, currency speculators spread rumours that sterling might be devalued.

Rumours Denied

These rumours were quickly denied by the Chancellor of the Exchequer. The reimposition of HP restrictions was evidence that the Government felt that steps must be taken to check spending at home because home demand was absorbing goods which should be going into export markets to earn foreign currency. The Autumn Budget with its increase in the purchase and profit taxes, combined with the credit squeeze by the banks, showed the Government's determination to deal with inflation dangers. On the other hand, the results of these anti-inflation measures were slow to become apparent though in the long run their cumulative effect must be considerable. On the other hand, at the same time there have been substantial wage increases which have given a fresh stimulus to inflation trends.

At the present time wage increase demands amount to no less than £500,000,000 and the big talking point is whether Mr. Macmillan, the new Chancellor of the Exchequer, will propose fresh steps against inflation, or wait until the Budget in April to see how things develop. The latest revenue returns, which give grounds for expectations of a good Budget surplus, have helped sentiment in stock markets, though on the other hand, it is realized that if inflation remains a danger, tax reductions can hardly be expected. There is a school of thought which argues that we may not have fresh measures against inflation so long as sterling remains steady in world markets, and so long as there is no fresh heavy fall in our gold and dollar reserves.

This is the background to the trends in stock markets in the past twelve months, and also to chemical and allied shares and their present rallying tendency. Sentiment in the past few weeks has been helped by news of dividend increases from well known companies in leading industries. It is being assumed that companies will pay somewhat higher dividends if profits increase, though on the other hand, few are likely to reduce their allocations to reserves. The great majority of companies place to reserves a large part of their profits—a policy which is not likely to be revised now that the credit squeeze by the banks means that loans and overdrafts have to be repaid.

Financial results of chemical and allied companies issued in the past 12 months have created an excellent impression and have shown that the industry is continuing to expand and develop. Imperial Chemical shares, which are 49s 6d at the time of writing, have had extreme prices of 61s 9d and 39s 1½d in the past 12 months.

Albright & Wilson 5s shares, which are now 21s 4½d, have had extremes of 22s and 19s 1½d in the past 12 months, and have been an active market since the expansion indicated by the acquisition of Marchon Products.

Reichhold Chemicals 5s shares were prominent, and are now 22s 6d, which compares with extreme levels of 22s 6d and 14s 6d last year.

Borax Outstanding

Borax Consolidated were an outstanding share of the year, having had extreme levels of 82s 6d and 172s 6d. The current price is 170s. The big rise has been due to wider recognition of the company's expanding business and to the assumption that in future a larger part of net profits is likely to be distributed in dividends.

Anchor Chemical 5s shares are now 14s 6d, equal to their highest reached last year; last year's lowest was 11s 4½d. Laporte 5s shares fluctuated between 18s 6d and 14s 6d last year; the current price is 17s 10½d. The year's extremes for Monsanto were 38s 3d and 25s and the current price 28s.

Lawes Chemical 10s shares had extremes of 16s 6d and 13s 9d, which compares with the current price of 16s 4½d. British Glues & Chemicals 4s shares, which have recently been a lively market on deal rumours that have now been officially denied, are 17s 10½d, which compares with extreme levels of 19s 3d and 12s last year. Hardman & Holden 5s shares are now 13s 3d; last year's highest and lowest were 15s and 11s 3d. There has been considerable activity in Hickson & Welch 10s shares, which are now 30s, equal to their highest last year; the year's lowest was 17s.

Fisons, which are now 56s 9d, moved between 52s and 67s 3d last year. Brotherton 10s shares had extremes of 30s and 41s last year and are now 36s 3d. Elsewhere the current price of 14s for the 5s shares of British Chrome Chemicals compares with 1955 highs and lows of 15s 3d and 10s 9d.

Following Prevailing Trend

It will be seen therefore that although chemical shares are generally below the best levels touched in 1955, they are mostly well above the lowest levels recorded in the 12 months. This is in line with the general trend in industrial shares. In fact it seems likely that for the time being at any rate, chemical shares must be expected to move quite closely with the prevailing trend in stock markets. This may show fluctuations because it could be that until the April Budget arrives it will be difficult to assess the outlook. A factor which is considered of great importance is that all the signs are set for further expansion in industrial activity in the US which is bound to have a stimulating effect on world trade. A point which is not overlooked is that our trade rivals in Europe also have inflation problems to solve.

Among other prominent shares Unilever's current level of 74s 3d compares with 1955 extremes of 80s 3d and 55s 7½d. The 6s 8d units of The Distillers Co. moved between 22s 9d and 34s 9d last year and are now 24s. The year's extremes for Staveley were 84s 9d and 55s 6d and the current price is 67s 6d. Courtaulds' extremes for the year were 54s 9d and 35s 3d and the current price is 43s 9d. British Celanese are now 22s 3d; extremes in 1955 were 20s 9d and 24s 3d. Triplex Glass 10s. shares are now 44s 3d; extremes in 1955 were 36s 3d and 49s 6d.

There is no doubt that present indications are that competition both at home and abroad will become much keener, and that it will be more difficult to earn larger profits unless a company succeeds in expanding turnover a good deal. The margin of profit generally will become smaller, it seems. In fact, the uniformly good financial results which have been the feature of chemical and other company news is unlikely to continue. Fluctuations in results as between one company and another will be expected to become much more in evidence. In the circumstances there is a strong case for the issue of half-yearly profit statements or progress reports to shareholders.

This is becoming a much more general practice in the company world, and this year it can be expected it will be more widely adopted by chemical companies. Both Imperial Chemical and Monsanto already do this, and Mr. Desmond Abel Smith, chairman of Borax Consolidated, has taken the lead in issuing a progress report whenever any important development takes place in the company's affairs. There is widespread evidence that it is appreciated by shareholders.

In view of the credit squeeze by the banks, it would not be surprising if a number of chemical companies have to raise additional capital this year. It seems likely that the credit squeeze may remain in force for about six months at least, and meanwhile another talking point is whether a fresh increase in the bank rate is in prospect.

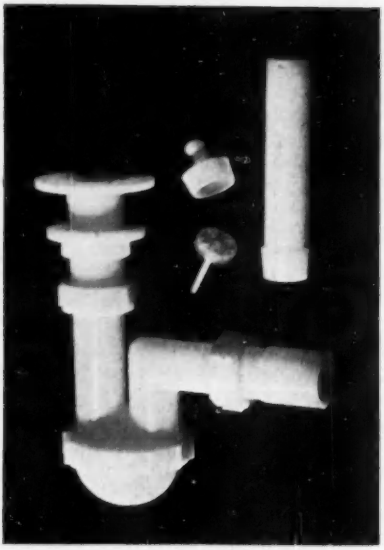
There are of course many problems to face, but the prevailing view is that chemical companies should have no difficulty in maintaining dividends at last year's rates, and in fact the assumption at the present time seems to be that a number of leading groups may pay somewhat higher dividends. It is this hope, combined with general recognition of the progressive policy being followed by most companies in the industry which explains why the prevailing view is that chemical shares are a sound long-term investment.

J. Peers & Associates Ltd.

Mr. J. Peers, managing director of Rooster Publicity Ltd., announces that the title of his company is changed to J. Peers & Associates Ltd. The headquarters of the organization is now Summit House, 1-2 Langham Place, London W1, with branches in Newcastle, Peterborough, and Teddington.

Polythene Sink Trap

AN acid-resistant laboratory sink trap, made completely of polythene, is being marketed by X-Lon Products, of 481 Gillingham Street, London SW1.



The trap illustrated has a 1¼ in. bore and can be fitted into any laboratory sink. The tail of the waste is available in 3½ in. and 4 in. diameters and can be varied where necessary. The strainer should be placed in the top of the waste and the sink cap then stopped either by the plug or by the standing tube if a high water level is required.

The coupler has been designed with a long sleeve so that the trap may be easily adapted to existing waste equipment by slipping the pipe into the sleeve and clamping it together.

Honoured in Rangoon

AMONG those who will speak at the opening ceremony of the temporary production unit of the Burma Pharmaceutical Industry near Rangoon to-day (14 January), will be Mr. Ian Fergusson, chairman and managing director of Evans Medical Supplies Ltd., of Liverpool. Following the ceremony he will attend a reception in his honour at the Kanbawza Palace. A great great grandson of Mr. John Evans who founded Evans Medical in 1809, Mr. Fergusson has played a major part in establishing a pharmaceutical industry in Burma, a project expected to be fully completed by the end of this year.

On 20 October 1953 Evans Medical Supplies Ltd. entered into an agreement with the Government of Burma to advise on the establishment of a pharmaceutical industry in Burma. Under the agreement Evans have advised on the selection of architects and consultant engineers, assisted in the design and layout of buildings, purchased all plant and equipment, and provided technical staff until Burmese Nationals (trained by Evans) were ready to take over. Also under the agreement Evans will manage the industry for an initial period of seven years. To date £1,250,000 of plant and equipment have been ordered including the alcohol and yeast plant which APV Co. Ltd., of Wandsworth Park, London, are supplying.

Nickel Industry in 1955

FREE world nickel production in 1955 again set a record with output estimated at about 427,000,000 lb., Dr. J. F. Thompson, chairman of the board of directors of The International Nickel Co. of Canada Ltd., said on 6 January in a review of the nickel industry. This is an increase of approximately 40,000,000 lb. over the previous record of 387,000,000 lb. in 1954, and 87,000,000 lb. over free world production in 1953.

'Total output by producers in Canada,' Dr. Thompson said, 'is expected to reach 347,000,000 lb. in 1955, also constituting a new high. This production is some 24,000,000 lb. higher than in 1954, and represents about 81 per cent of the free world production. Of the remaining free world production, Cuba accounted for approximately 7 per cent; New Caledonia, 5 per cent; Japan, 3 per cent; US, 2 per cent, and various other countries 2 per cent.

'International Nickel's output of the metal in 1955 from its own ores reflected capacity production for the sixth consecutive year. The company's deliveries of about 285,000,000 lb. of nickel in all forms will be the highest in its history, representing approximately 65 per cent of the free world's supply.'

Temperature Control

Fielden Aid Terylene Production

PRODUCTION of Imperial Chemical Industries' newest synthetic fibre, Terylene, is carried out in a modern plant which was put into commission at their Wilton Works last year. It involves a complicated chemical process, and the actual processing of the spun yarn requires new techniques in process instrumentation.

At the drawn-twist stage of production, it is absolutely essential that the temperature be carefully monitored and controlled. As over 2,700 temperature points were involved, conventional methods of temperature control and indication would have proved prohibitive, owing to the large initial capital cost.

It was decided that, as long as all the points remained within the tolerances set for them, there was no need to indicate them. But it was necessary to have an alarm if any point moved outside its tolerance, and in that case the actual temperature should be indicated. With this in mind, and through co-operation between the engineers of Imperial Chemical Industries Limited and Fielden Electronics Limited, a suitable economical system was evolved.

Basic Principle

The basic principle of this system is to use a relatively inexpensive thermostat to control the various points, but to scan them automatically with a high precision instrument which gives the necessary alarms should a particular point be off control.

Each machine has 112 heater plates arranged in two lines of 56, one line on either side. The thermostat and heater are in one unit which also incorporates the pocket for the thermocouple. The 112 thermocouples are connected to the automatically driven scanning switch through special compensating cables; the information from each thermocouple is given successively to the temperature indicating instrument via this motorized switch.

The instruments which are used on this installation are Fielden DC potentiometers. The system is arranged so that the 112 points are checked every 11 minutes; this gives a single point examination approximately every six seconds. Before going into service the prototype switch was given the equivalent of 20 years' service, after which it showed no appreciable wear or change in contact resistance.

The scanning equipment checks each point in succession. Should one point be outside the limits required, a visual alarm is given and the automatic scanning switch stops at the point which is wrong; the Fielden DC potentiometer indicates the incorrect reading. It is necessary for the operator to restart the system by operating a push button which, at the same time, cancels the visual alarm. The system is so arranged that this manual operation must be performed to restart the system after a fault to ensure that the plant operatives take corrective action, should any alarm be given.

Chemical Section Report

THE annual report for 1955 of the chemical and allied section of the Manchester Chamber of Commerce suggested that 1956 will be another year of advancement in sales and service. Chemical manufacturers, said the report, had suffered from increased costs of labour, fuel, raw materials and transport and in most cases these had more than offset benefits which consumers might have gained from improvements in productive efficiency. Without these improvements, manufacturers would from necessity have had to confront their customers with price increases far greater than those which had been made.

The average level of production within the chemical and allied trades in the first six months of 1955 was 66 per cent higher than that for the whole of 1948, while the comparable increase for the whole manufacturing industry was 43 per cent. This production increase within the chemical and allied trades since 1948 had been accompanied by a rise in employment figures of only 17 per cent.

Italy's First Platformer

The first platforming unit in Italy is to be commissioned this month at the Porto Marghera refinery, Venice, which is jointly owned by BP and Azienda Generale Italiana Petroli. The unit will have a capacity of 75,000 tons a year and will produce a high grade motor spirit component by a reforming process using a platinum catalyst. It is the seventh platformer to be built for refineries of the BP Group.

• HOME •

Informal Discussion

The metallurgical engineering committee of the Institute of Metals will sponsor an all-day informal discussion on 'Furnace Refractories for the Use of the Non-Ferrous Metal Industries' at the University, Edgbaston, Birmingham 15, on 24 February at 10.30 a.m.

Fire & Water Damage

Three tons of hessian were damaged when fire broke out on 22 December at the Dunlop Rubber Co. factory, Walton, Liverpool, and quantities of zinc chloride sodium difluoride and sulphur were damaged by water. Production was not affected.

Industrial Accidents & Diseases

Fatal industrial accidents in November in the UK totalled 115, one more than was reported in October, and 12 more than in November 1954. Of these, five were recorded from chemicals, oils, soaps and allied trades, and two from metal extracting and refining. Of 25 cases of epitheliomatous ulceration (skin cancer) reported among pitch and tar and mineral oil workers, seven deaths resulted; four from pitch and tar, three from mineral oil. There were 22 cases of chrome ulceration recorded.

Index to Theses

The Association of Special Libraries & Information Bureaux, of 4 Palace Gate, London W8, announces publication of Vol. 2 of the 'Index to Theses Accepted for Higher Degrees in the Universities of Great Britain and Ireland', covering the academic year 1951-52. Vol. 1 (1950-51) of the Index has been reprinted and copies are now available at 25s each volume (21s to members of ASLIB).

Seeking Assured Water Supply

Petrochemicals Ltd., chemical manufacturers, Partington Industrial Estate, Cheshire, seeking an assured water supply before making development plans, want to drill bore holes to draw up to 2,500,000 gallons of water daily. If permission is given, eight bore holes, 500 ft. deep, will be drilled near Carrington. At present the firm uses 15,000 gallons of water an hour for feeding boilers alone—and there will be a limit eventually to supplies from Corporation mains.

Anti-Waste Campaign

ICI's Nobel division is launching an anti-waste campaign with a wider appeal than in the past. As from this month all factories are being asked to conserve raw materials, achieve the largest production from the smallest consumption of these materials, and improve the competitive strength of the group by making a maximum effort to cut all waste. Pictorial methods will be used to put the campaign over and prizes will be given for the best results.

Food & Drugs Amendment Act

The Minister of Agriculture, Fisheries and Food, the Rt. Hon. D. Heathcoat Amory, MP, has made an Order bringing the Food & Drugs Amendment Act, 1954 into operation on 1 January 1956. The Food & Drugs Act, 1955 comes into operation immediately afterwards. The Food & Drugs Amendment Act, 1955 (2 & 3 Eliz. 2 Ch. 67) received the Royal Assent on 25 November 1954. Section 37 provided that (with the exception of Section 28 which came into operation on the passing of the Act) the Act should come into operation on a day appointed by the Minister.

Microchemistry Group Meeting

Before the annual general meeting of the microchemistry group and an ordinary meeting of the Society for Analytical Chemistry at Burlington House, Piccadilly, London W1, on 27 January, there will be a visit during the afternoon to the research laboratories of Kodak Ltd. at Harrow. Following the meetings in the evening two papers will be read: 'Microchemical Methods in the Art Gallery & Museum' by A. E. Werner, M.A., M.Sc., D.Phil., A.R.I.C., and 'The Ring-Oven Technique & Its Application in Archaeology' by H. Weiesz, Dr. Tech. Dipl.-Ing.

Showrooms Closed

British Filters Ltd. have announced that the lease on their Berkeley Street showrooms has expired and until new premises are available all correspondence should be addressed to the head office at Maidenhead, Berks; telephone: Maidenhead 4144; cables and telegrams: Filtersphone Maidenhead.

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OVERSEAS

Two Fertilizer Plants

W. & H. M. Goulding Ltd., of Dublin, have announced plans for the building of two new fertilizer factories in Cork and Sligo.

US Chemical Industry Growth

In the past year the chemical industry of southern US completed privately financed construction projects valued at nearly $713,000,000, planned new construction valued at $229,500,000, and started construction valued at $605,500,000.

Indian Coal Tar

A quota of 1,000 tons of Indian coal tar has been fixed for export to all permissible destinations other than Portuguese possessions in India during January-June 1956. Export will be licensed on shipping bills, validity of which will be restricted to 15 days, and export of more than 250 tons per shipper per day will not be permitted.

Cupola Lining

Experiments with rammed tarred dolomite for lining a basic cupola have been tried by Wright Boag & Head Wrightson (Pty.) Ltd., Benoni, Transvaal. Initial runs indicate that this is a suitable material in regard to the quality of the metal produced and the life of the lining. Tarred dolomite is cheaper than other lining materials. Cullinan Refractories Ltd. produced the tarred dolomite and furnished technical advice.

Pfizer Granted Injunction

A Cuban court has granted Charles Pfizer & Co. Ltd. an injunction against E. R. Squibb & Sons Inter-American Corp., prohibiting the sale, distribution or use of the broad spectrum antibiotic, tetracycline. The decision was based on an action for patent infringement instituted by Pfizer last September, which followed soon after the grant to Pfizer of basic patent protection on tetracycline in Cuba. Tetryacycline is a discovery of Pfizer Research.

Dutch Firm to Have Canadian Branch

The first Canadian branch of the old established Dutch firm, Glue & Gelatine Works of Delft, Holland, will be built in Trenton, Ontario. The plant will produce edible and technical gelatine for use mainly by the food, photographic and pharmaceutical industries.

Montreal Conference

About 1,500 chemists and chemical engineers are expected to attend the 1956 conference of the Chemical Institute of Canada in Montreal on 28, 29 and 30 May.

Russian Offer

Syria is studying a Russian offer to supply a complete new oil refinery at a bargain price, official circles reported in Damascus recently. The refinery offer is reported to have been presented by Mr. Serge Nemchina, the Soviet Ambassador, and to have included the services of Russian experts in building the installation.

New CIBA Dye

CIBA research has led to the development of a homogeneous black which has been included in the Cibalan range of dyes. The new dye, known as Cibalan black BGL, yields charcoal grey and full black shades of high fastness to light, washing, and milling on wool, polyamide fibres, and silk. It is also said to be suitable for the production of solid black shades on wool/polyamide fibre unions.

Oil Search in Niger Delta

After two years of continuous operations a Shell-D'Arcy surveying party has finished a water-borne seismic survey of all the navigable Niger Delta waterways in Eastern and Western Nigeria. Their search for oil has covered an area of 14,000 sq. miles. So far Shell-D'Arcy have spent 18 years and about £12,000,000 in searching for oil in Nigeria.

Weed-Killer Produced

The weed-killer 2-4D is now being produced by the Makhteshim Chemical Works Ltd. of Beersheba. Makhteshim is believed to be the only chemical plant in the Middle East producing 2-4D. The factory was opened in 1954, when chlorine was produced for the first time, and this was followed in April 1955 by the production of insecticides like DDT, Dieldrin and Aldrin. The factory also produces quantities of benzene hexachloride and has lately begun exporting liquid chlorine. All chlorine products are made from Sdom salts, and the factory is producing sufficient of these chemicals to cover the needs of Israel and leave some for export as well.

It is a common practice to use standard "Klingerit" jointing for many kinds of acids, but it is not suitable for nitric acid and a few other concentrated acids. "Klinger-Acidit" is therefore produced as a compressed asbestos jointing designed to resist hot nitric acid, hydrochloric acid, sulphuric acid, organic acids, etc. It is supplied in two qualities, hard and soft, and can be safely used for steam and pressures of up to 250 p.s.i. and is not damaged by oils, petrol, gasoline and other solvents, although it is not primarily intended for such uses.

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C/1155/1

· PERSONAL ·

DR. F. J. WILKINS, an executive director, has been appointed a director of Glaxo Laboratories Ltd.

MR. D. P. C. NEAVE, vice-chairman of the Consolidated Zinc Corp. Ltd., has been elected chairman of the Zinc Development Association as from 1 January 1956. The former chairman, MR. WILLIAM MURE, managing director of the British Metal Corp. Ltd., will continue as a member of the council of the association.

MR. MILES B. REID resigned from his directorship of Stephenson Clarke Ltd. with effect from 31 December 1955 to enable him to devote more time to his duties in connection with his directorships of Powell Duffryn Ltd., Mobil Oil Co. Ltd., and other companies.

MR. FRANK JUDSON, industrial general sales manager, Mobil Oil Co. Ltd., was awarded the M.B.E. in the New Year Honours List. Mr. Judson, who has been associated with Mobil Oil Co. for 41 years, has served the company with distinction in many areas of the UK and for four years in China.

DR. JAMES HENDERSON has completed 60 years as a Fellow of the Chemical Society. Now aged 84, he graduated at St. Andrews in 1895 and then studied at Munich, working later at Meissen in Germany and then at McGill in Toronto as senior demonstrator in chemistry. He joined the Horlicks organization from McGill and for nearly a quarter of a century was chief chemist at Racine on Lake Michigan; on his return to Britain he continued as scientific adviser to the British end of the Horlicks organization at Slough, Bucks. Now resident in Dundee, Mr. Henderson lived earler at St. Andrews, in the Channel Islands and in South Africa.

COLONEL CHARLES E. PONSONBY, T.D., D.L., B.A., past-president, Glass Manufacturers' Federation and a member of the council of the British Glass Industry Research Association, was created a baronet in the New Year Honours List. Colonel Ponsonby, who has been chairman of Forster's Glass Co. Ltd., St. Helens, since 1937, is chairman of the Federation's public relations committee and has been a member of the council of the Glass Delegacy for several years.

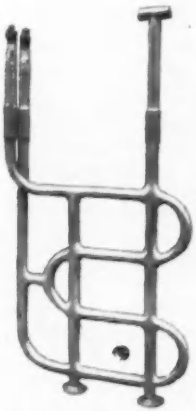
MR. J. G. FISHER, B.A., and MR. L. D. STEWART, B.Sc., have been appointed directors of the paints division of Imperial Chemical Industries Ltd. Mr. J. G. Fisher, an Australian who graduated at Cambridge in 1932, joined the service department of Nobel Chemical Finishes Ltd., Slough, later in the same year. During the war he did a lot of work in connection with the provision and service of aircraft finishes. In 1946 he returned to Australia and for four years occupied a post with the British Australian Lead Manufacutrers (Pty) Ltd. He returned to Britain in 1950 and shortly afterwards was appointed Midland industrial paints sales manager for ICI's paints division, becoming the home sales control manager on 1 March 1955. Mr. L. D. Stewart, a graduate of Birmingham University, joined Frederick Crane Chemical Co. Ltd., the Birmingham cellulose lacquer undertaking, on 3 March, 1923. In 1934 he became assistant general manager. From 1936 to 1939 he was head of the commercial sales department of Nobel Chemical Finishes Ltd. Appointed industrial sales manager in 1941 and home sales manager in 1946, Mr. Stewart became overseas relations manager of the division in March last year.

DR. J. SLEIGHTHOLME has been appointed technical director of the Beaver Paint Co. Ltd., Liverpool, as from 1 February in succession to MR. W. BROMLEY, who has resigned from the company.

The Macaulay Institute for Soil Research, Aberdeen, has announced that DR. R. L. MITCHELL, Ph.D., B.Sc., head of the Department of Spectro-Chemistry at the Macaulay Institute has been appointed deputy director. Dr. Mitchell joined the staff of Macaulay Institute in 1934. DR. E. G. WILLIAMS has been appointed head of the Department of Soil Fertility.

Will

MR. WILFRED HIPKINS, of 24 Shepley Drive, Hazel Grove, Manchester, formerly managing director of Reddish Chemical Co. Ltd., left £56,614 (duty £19,917).



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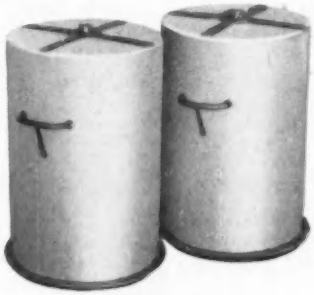

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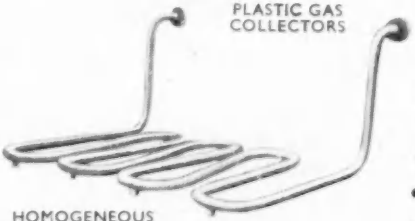

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Obituary

MR. R. E. BRETT, chief of process development at the Hackney, London, chemical works of W. J. Bush & Co. Ltd., died suddenly on 20 December from heart failure. Mr. Brett, who joined the company in 1910, was a senior executive in all the company's chemical manufacturing operations.

MR. HERBERT WYLIE, a pioneer in the development of the oil resources of Mexico, died on 3 January at his home in Los Angeles, California. He emigrated to the US at the age of 19 and became general superintendent of the Mexican Petroleum Co. in 1902. He built the Mexican company up into one of the biggest oil enterprises in the world at that time and was president of the company when he retired 25 years ago.

MR. FRANK SHERWOOD TAYLOR, director of the Science Museum, South Kensington, died in hospital in London last week at the age of 58. From 1933 until 1940 he was an assistant lecturer in chemistry at Queen Mary College, University of London. For the next 10 years he was curator of the Museum of the History of Science, Oxford, being appointed director of the Science Museum, South Kensington, in 1950. He was well known as a writer on scientific subjects and was, in addition, a governor of the Imperial College of Science and Technology.

MR. S. J. MATTHEWS, A.M.I.E.E., M.I.I.A., A.M.I.Prod.E, head of the research and development division of Baird & Tatlock (London) Ltd. since 1949, died suddenly on 2 January. Mr. Matthews was responsible for the design and re-design of many of the company's items of laboratory equipment. The main items introduced by the company in recent times were the Analmatic automatic laboratories first shown at the 1955 British Instrument Industries Exhibition (see THE CHEMICAL AGE, 1955, **73**, 1275). SIR BERNARD KEEN, D.Sc., F.Inst.P., F.R.S., is temporarily taking charge of the research and development division.

Chemical Engineering Chair

A chair of chemical engineering has been established in the faculty of technology at Manchester University. Professor Frank Morton, professor of chemical engineering at Birmingham University, has been appointed to the new chair and will take up his duties in April.

OCCA Technical Exhibition

THE eighth technical exhibition of the Oil & Colour Chemists' Association will be held on 20, 21 and 22 March at the Royal Horticultural Society's New Hall, Grey Coat and Elverton Streets, London SW1. Preparation of the exhibition brochures has now been completed and copies will shortly be distributed.

The Rt. Hon. Viscount Waverley, G.C.B., G.C.S.I., G.C.I.E., F.R.S., president of the Parliamentary and Scientific Committee, will open the exhibition at 3 p.m. on 20 March. The area covered by the exhibition will be larger than ever before and the total number of companies and research associations exhibiting, 82 in all, is the largest yet reached.

Copies of the exhibition brochure and further information can be obtained from the general secretary, Oil & Colour Chemists' Association, Memorial Hall, Farringdon Street, London EC4.

Oil Preserving Slug

TWO scientists attached to the Canadian National Research Council's division of applied chemistry have developed a calcium alloy slug which will permit automobiles to travel 20,000 miles without changing oil. The scientists, Dr. E. E. Puddington, director of NRC's division of applied chemistry, and Dr. A. F. Sirianni, claim that the slug enables engine oil to retain its lubricating qualities as long as no foreign matter gets into the oil. In tests two cars travelled 22,000 miles without needing a change of oil.

The slug, which is attached to the drain tap on the oil pan, was developed in May 1953. It will be manufactured by a Toronto company which has been licensed to produce them at a cost of $3.

Nuclear Power Venture

The Hawker Siddeley Nuclear Power Co. Ltd. has been formed by the Hawker Siddeley Group with Sir Roy Dobson as chairman. Mr. E. P. Hawthorne, of Harwell, will be chief executive of the company. Announcing this in London recently, Sir Frank Spriggs, managing director of the group, said that the new company will be engaged in 'research and development'.

Publications & Announcements

AN ACCOUNT of the international conference 'Function and Training of the Chemical Engineer in Europe', held in London from 21 to 23 March last year, has been published in booklet form by OEEC. The booklet, 85-pages, entitled 'Function and Training of the Chemical Engineer', is available from HMSO and agents, price 8s 6d. In its report of the conference, the booklet covers all aspects and lists the names of all delegates who attended. The conference was divided into six sessions under the following headings:— 'The Part played by the Chemical Engineer in Bridging the Gap Between Research and Plant Construction'; 'The Chemical Engineer in Plant Operation and Management'; 'Model Courses of Study for a Primary Degree in Chemical Engineering'; 'Other Educational Schemes in Chemical Enginering'; 'The Practical Training of the Chemical Engineer Before and After Entry into Industry'; and 'Chemical Engineering Research: its Future and Scope'.

* * *

WELL over 3,000 organic chemicals are listed in the 1956 price list published by L. Light & Co. Ltd., Poyle Trading Estate, Colnbrook, Bucks. This list, which cancels previous lists, contains a wide range of biochemical products, nearly all of which are available from stock. A supplement has also been published, in which is given, in addition to the prices of compounds not listed in the main volume, an account of the Resazurin test for estimating the hygienic quality of milk.

* * *

THE Aluminium Development Association, of 33 Grosvenor Street, London W1, has just published its 27th research report, 'Researches into the Welding of Aluminium and its Alloys', price 7s 6d. This is a summary of the work of the Association's welding research team carried out at the University of Birmingham from 1944 to 1950. The team was originated by the Wrought Light Alloys Association and subsequently sponsored by the Aluminium Development Association. Its investigations into the welding characteristics of aluminium alloys began in July 1944 under the supervision of Professor D. Hanson, continued under Professor L. Aitchison, and were concluded, with recommendations on the most suitable welding alloy compositions, in August 1949. Between the appearance of the first progress report in December 1947 and the present final summary, the team leaders—Dr. A. R. E. Singer, succeeded by Dr. W. I. Pumphrey—and their associates have issued reports of particular investigations which generally have been presented to the appropriate learned societies before inclusion in the ADA research report series. A full list of the papers produced by the team is given in the present report. This report was issued in order to make the results more readily available to industry and so to encourage the use of welded aluminium.

* * *

A NEW miniature contactor which should find application in automation and the chemical industry has been designed by Besson & Robinson Ltd., East Industrial Estate, Harlow, Essex. Among the features claimed for this appliance are small size ($3\frac{1}{8}$ by $1\frac{7}{8}$ by $2\frac{1}{2}$ in.) and high power rating. The contacts have a continuous rating of 20 amps at 250 volts AC. The coil consumption is low and B & R say that it should prove suitable for interposing between sensing elements such as contact thermometers and mains loads such as heaters and solenoids. The construction is designed to give rapid operation on AC and DC and silent operation on AC.

* * *

COMPREHENSIVE details of the world's airlines are contained in the December issue of the *ABC World Airways Guide*. The guide, which is revised and published monthly, price 7s 6d (8s 2d by post), by Thomas Skinner & Co. Ltd., Gresham House, Old Broad Street, London EC2, contains the timetables and tariffs for all regular scheduled air services. Divided into two sections—an alphabetical fares index and a timetable of services—the sections are linked by simple detailed references. Particulars of fares are given in basic currencies, sterling and dollars, and in local currencies, and cover single, return, tourist and off-season rates. Other information includes passport and visa requirements, international health regulations, and currency and exchange rates.

Law & Company News

Commercial Intelligence

The following are taken from the printed reports, but we cannot be responsible for errors that may occur.

Mortgages & Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described herein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages or Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary but such total may have been reduced.)

NORMAN, SMEE & DODWELL LTD., Mitcham, paint manufacturers etc., 7 December, £7,500 equitable mortgage to Hygienic Wire Works Ltd.; charged on factory premises at Miles Road, Mitcham. *£11,000. 11 November, 1955.

SILVERTHORN MANUFACTURERS LTD., Chingford, chemists.—7 December, by order on terms, series of £5,500 (not ex.) debentures, present issue £3,500; general charge. *£3,500. 8th July, 1955.

Satisfaction

KAY'S (RAMSBOTTOM) LTD, soap manufacturers etc.—Satisfaction 14 December, of debenture registered 8 November, 1952, to the extent of £2,000.

Increases of Capital

A. WANDER LTD., chemists, druggists and analytical chemists etc., 42 Upper Grosvenor Street, London W1, increased by £1,000,000, in £1 ordinary shares, beyond the registered capital of £1,000,000.

BRITISH ALKALOIDS LTD., Pinner's Hall, Austin Friars, London EC2, increased by £50,000, in 1s ordinary shares, beyond the registered capital of £150,000.

ALBRIGHT & WILSON LTD., Oldbury, Birmingham, increased by £3,500,000, in 6,084,852 ordinary shares of 5s, and 1,978,787 unclassified shares of £1 each, beyond the registered capital of £5,500,000.

BRITISH RATIN COMPANY LTD., rat extermination etc., 125 Pall Mall, London SW1, increased by £100,000, in £1 ordinary shares, beyond the registered capital of £50,000.

ANCHOR TRADING CORP. LTD., 125 Pall Mall, London SW1, increased by £30,000, in £1 ordinary shares, beyond the registered capital of £30,000.

New Registrations

Merseyside Auto-Corrosive Services Ltd.

Private company (559,146). Capital £5,000 in £1 shares. To carry on the business of buyers and sellers of and dealers in all kinds of chemicals, chemical compositions, paints, colours, varnishes etc. Subscribers (each with one share): George C. Lees and W. Thomson. Reg. office: Lanofilm Works, Longmoor Grove, Aintree, Liverpool 9.

'Del-Fre' Products Ltd.

Private company (559,584). Capital £1,000 in 1s shares. To carry on the business of manufacturers of and dealers in chemicals, gases, drugs, medicines etc. Directors: Nathaniel H. E. R. Cookman and Mrs. Helen J. Cookman, of 'Forestways', 106 Honey Lane, Waltham Abbey, Essex. Secretary: Helen J. Cookman. Registered office: 2, Stone Buildings, Lincolns Inn, London WC2.

Dr. Augustus Voelcker & Sons Ltd.

Private company. (559,477). Capital £105. To acquire the business of analytical chemists now carried on by Eric Voelcker at Stuart House, 1 Tudor Street, London EC, and to carry on the business of analytical chemists and consultants in all matters relating to the identification of matter or agricultural or horticultural matters etc. Directors: Eric Voelcker, 30 Queens Gate Gardens, London SW7, Capt. John B. Heath, O.B.E., Hardington House, Hardington Mandeville, Yeovil, Oswald J. Voelcker, C.B.E., M.A., A.I.C.T.A., and Robert A. Collet. Registered office: Candlewick House, 116-126 Cannon Street, London EC4.

Aerosoltherapy & Disinfestation Ltd.

Private company (558,516.) Registered 10 December. Capital £1,000 in £1 shares. To exploit in the United Kingdom and elsewhere the processes of M. Gauchard in respect of the use of aerosols and all filters and other apparatus, disinfectants and other chemical products designed or invented by him; and to carry on the business of consultants, advisers and research workers in

[continued on page 214

connection with respiratory maladies of all kinds etc. The subscribers (each with one share) are: Roger L. Del Fosse, and Jean L. R. Lloyd. Roger L. Del Fosse is the first director. Secretary: Shirley Horn. Solicitors: Boxall & Boxall, 22 Chancery Lane, London WC2.

EM Chemicals Ltd.

Private company (558,391). Capital £7,500. Manufacturers of and dealers in chemicals and drugs of all kinds; chemical research workers. Directors: R. D. Swan and T. H. Campbell Wardlaw. Reg. office: 9, Market Street, Newcastle-on-Tyne.

Company News

Morgan Crucible

The board of Morgan Crucible has declared an interim dividend of 3¾ per cent on capital increased from £2,459,960 to £4,304,930 by a three-for-four scrip issue from reserves against 6 per cent on the smaller amount. The final of 9 per cent and bonus of 2¼ per cent brought the distribution for the year to 31 March 1955 to 17½ per cent on £2,459,960.

British Glues & Chemicals Ltd.

A 50 per cent scrip issue and interim dividend, maintained at 5 per cent for the year to 31 March, are announced by British Glues & Chemicals Ltd. The new capital will not participate in the interim, but will rank for the final dividend.

Scottish Agricultural Industries Ltd.

Presiding at the 28th annual general meeting of the Scottish Agricultural Industries Ltd., Mr. H. U. Cunningham, C.B.E., M.C., the managing director, said that for the year under review gross sales had amounted to £23,194,153, a record for the company. Net profit after deducting taxation and setting aside other sums was £462,045, compared with £449,337. The directors have recommended a 7 per cent dividend on the ordinary shares which, together with the interim dividend of 4 per cent, will make a total payment of 11 per cent, the same as last year.

New Address

New address of Evans Electronic Development Ltd. is Evonic Works, Shady Lane, Great Barr, Birmingham 22a. Tel.: Great Barr 1764.

Atomic Energy as a Career

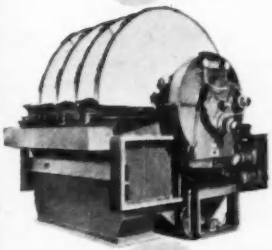
ATOMIC energy as a career for youth is the subject of a booklet published by the UK Atomic Energy Authority. In an introduction to the 24-page booklet 'Atomic Energy—Career for Youth', Sir Edwin Plowden, K.C.B., K.B.E., chairman of the UKAEA, writes: 'It is worth recalling that my colleague Sir Christopher Hinton, now managing director of our industrial group, began his career, at the age of 16, as an engineering apprentice in the Great Western Railway's workshops at Swindon'. The booklet gives details of varying craft apprenticeships in the atomic energy field, pay rates, and information on how to apply for apprenticeships. Copies of the booklet can be obtained free from The Chief Labour Officer, UKAEA, Bedford Chambers, Covent Garden, London WC2.

Symposium Reports

THE Chemical Society has published the reports of two symposiums. Called 'Special Publications', No. 1 is the report of the symposium on 'The Kinetics & Mechanism of Inorganic Reactions in Solution—A Survey of Recent Work' held on 4 February 1954. It is available from the General Secretary, The Chemical Society, Burlington House, Piccadilly, London W1, price 5s to fellows; 8s to non-fellows. Special Publication No. 2, covering the 'Symposium on Peptide Chemistry' held on 30 March 1955, is available to fellows, price 7s 6d; 15s to non-fellows.

New Titanium Process

A major step forward in processing titanium for jet engines which will revolutionize production of supersonic engines was claimed on 5 January by Sir Roy Dobson, of the Hawker Siddeley Group. The process was developed by Canadian Steel Improvement, one of the Avro Canada Group of companies, of which Sir Roy Dobson is founder and chairman. In his statement Sir Roy said, 'We have developed a process which eliminates much of the difficulty in forging titanium, resulting in a substantial reduction in cost. We can forge finished jet turbine blades as cheaply as rough forging'.



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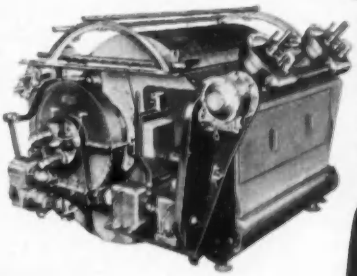
Whatever your filtration problem there is an Eimco Filter specially designed for the job. Eimco Filters have been built in close collaboration with industry for many years, and their world-wide use testifies to their efficiency and reliability. They are used in the Cement, Chemical, Coal, Food, Paper, Petroleum, Sewage, Starch, Sugar and other industries for Clarifying, Dewatering, Drying, Washing and other recovery processes.

Write for more information concerning the wide range of Eimco equipment available. Our free testing facilities and world-wide experience are at your disposal.



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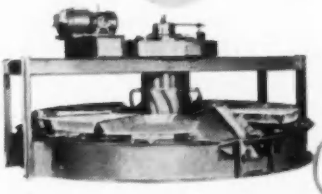

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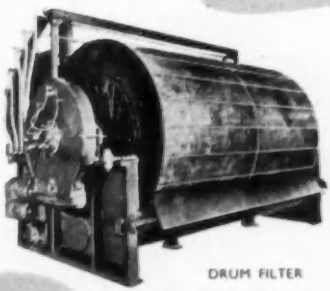

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Next Week's Events

MONDAY 16 JANUARY

British Ceramic Society

Stoke-on-Trent: North Staffs. Technical College, 7.30 p.m. 'The Relations Between the Properties & Constitution of Ceramic Bodies' by A. N. Smith, M.A.

Institute of Metal Finishing

London: Imperial College, South Kensington, 6.15 p.m. 'The Effects of Metal Finishing Wastes on Sewage Purification' by A. E. J. Pettet, M.A., M.Inst.S.P.

TUESDAY 17 JANUARY

SCI (Birmingham Section)

Birmingham: Birmingham & Midland Institute, Paradise Street, 6.30 p.m. 'Recent Advances in the Chemistry of Coal' by Dr. G. J. Lawson, B.Sc.; 'Studies in the Composition of Coal Tar' by Dr. J. Butler; and 'Liquid-Liquid Equilibrium for Systems α-Picoline-Hydrocarbon Solvents' by E. J. Charles, A.M.I.Chem.E.

WEDNESDAY 18 JANUARY

Oil & Colour Chemists' Association

London: Royal Society of Tropical Medicine & Hygiene, Manson House, 26 Portland Place W1, 7 p.m. 'Selective Hydrogenation of Tung Oil' by M. R. Mills, B.Sc., F.R.I.C.

SCI (Plastics & Polymer Group)

Cardiff: University College, 7 p.m. 'The Degradation of High Polymers' by Dr. N. Grassie, B.Sc., Ph.D.

SCI (London Section)

London: Institute of Metals, 4 Grosvenor Gardens SW1, 6.30 p.m. Joint meeting with RIC. 'Science in the Service of Archæology' by Dr. H. J. Plenderleith, M.C., F.R.S.E., F.S.A.

Royal Society of Arts

London: John Adam Street WC2, 2.30 p.m. Trueman Wood Lecture 'Benjamin Franklin in London' by Professor E. N. da C. Andrade, D.Sc., Ph.D., LL.D., F.R.S.

Society of Instrument Technology

Newcastle-on-Tyne: Stephenson Building, King's College, 7 p.m. 'Instrumentation as Applied to the Manufacture & Use of Atmospheric Gases' by B. Blay (British Oxygen Co. Ltd.).

Institution of Chemical Engineers

London: Institution of Civil Engineers, Great George Street SW1, 5.30 p.m. British Nuclear Energy Conference. 'The Use of Solium & Sodium-Potassium Alloys as a Heat-Transfer Medium.'

SCI (Newcastle Section)

Newcastle-on-Tyne: Chemistry Lecture Theatre, King's College, 6.30 p.m. Joint meeting with food group of SCI. 'Recent Progress in British Research in Fish Technology' by C. L. Cutting, B.Sc., Ph.D., F.R.I.C., and G. A. Reay, O.B.E., B.Sc., Ph.D., F.R.I.C., F.R.S.E.

THURSDAY 19 JANUARY

SCI (Road & Building Group)

London: 14 Rochester Row SW1, 6 p.m. 'The Use of Pulverized-Fuel Ash' for: (a) 'Brick Making' by B. Butterworth, B.Sc.; (b) 'Lightweight Aggregate' by W. Kinneburgh, F.R.I.C.

SCI (Yorkshire Section)

York: Royal Station Hotel, 6.30 p.m. Joint meeting with food group. 'The Technology of Milk Condensing' by G. B. Wright (Northern Dairy Group).

Institute of Metal Finishing

Birmingham: Grand Hotel, Colmore Row, 6.45 p.m. Annual Midland Dinner & Dance.

The Chemical Society

London: Imperial College, South Kensington SW7, 7.30 p.m. 'Recent Progress in the Chemistry of Peptides' by Dr. G. W. Kenner, M.Sc.

Bristol: Chemistry Department, The University, 7 p.m. Joint meeting with RIC & SCI. 'Industrial Applications of Sequestering Agents' by R. L. Smith & P. Womersley.

Liverpool: Lecture Theatre, The University, 5 p.m. 'Chemical Aspects of Nucleotide Biosynthesis' by Professor J. Baddiley, M.Sc., Ph.D.

Manchester: Room E.17, College of Technology, 6.30 p.m. 'Aromatic Substitution' by Professor M. J. S. Dewar, M.A.

SCI (Liverpool Section)

Preston: Town Hall, 7.30 p.m. 'The Disposal of Trade Effluent' by C. S. Evans.

FRIDAY 20 JANUARY

The Chemical Society

Cambridge: University Chemical Laboratory, Pembroke Street, 8.30 p.m. 'A Topic in Natural Product Chemistry' by Professor D. H. R. Barton, D.Sc., F.R.I.C., F.R.S.

[continued on page 218

Next Week's Events

continued from page 216

SCI (Fine Chemicals Group)

London: Chemistry Lecture Theatre, King's College, Strand WC2, 7 p.m. 'Solvents in the Chemical Industry' by E. Chadwick, M.Sc.

Society for Analytical Chemistry

Glasgow: 123 Sauchiehall Street, 5 p.m. Annual general meeting, followed at 7.30 p.m. by a film evening.

Incorporated Plant Engineers

Blackburn: Golden Lion Hotel, 7.30 p.m. 'Smoke Abatement' by J. Lewis, M.Inst.F., M.I.Plant E.

Market Reports

LONDON.—An active trade characterizes most sections of the industrial chemicals market, and reports show a fairly wide buying interest on home account. Export trade inquiry remains good and the supply position generally is satisfactory. Apart from the lower prices for glycerine, the trend in prices is to higher levels but actual changes have been few. There have been many fluctuations in rates with the non-ferrous metal compounds dearer on balance. Zinc oxide and zinc dust are higher while the lead compounds were revised on 7 January as follows: white lead £152 per ton, red lead £147 10s per ton, and litharge £149 10s per ton. A steady trade has been reported in the coal-tar products with carbolic acid, phenol crystals and all grades of cresylic acid finding a ready outlet. Pitch is moving well on home and export account.

MANCHESTER.—Traders on the Manchester chemical market during the past week have reported a steady flow of delivery specifications against the extensive contracts that have been placed over the early part of the year, and on the whole requirements of the textile and other using industries are being met without much difficulty. A fair number of fresh inquiries on both home and export accounts have also been dealt with. Firm price conditions have been maintained in virtually all sections of the trade. In the fertilizer market there is a steady demand for basic slag, with a fair call for sulphate of ammonia and one or two other lines. Most of the tar products are going steadily into consumption.

GLASGOW.—The Scottish heavy chemical market has been very quiet due to the New Year holidays taking up the greater part of the week. However, towards the end some little activity can be reported with every prospect of a quick return to normal business.

Iraq Oil Refinery

IRAQ's first complete oil refinery, built for the government near Baghdad, is now on stream and has just been dedicated. Designed and engineered by The M. W. Kellogg Co., the new 24,000 BPD thermal refinery processes Kirkuk crude to produce fuel gas, stabilized gasoline, kerosine, light gas oil, Diesel oil, and residual fuel oil.

A single combination unit is responsible for this production—intergrating crude atmospheric topping, single-pass visbreaking of reduced crude, thermal cracking of gas oil, thermal reforming of heavy virgin naphtha, vacuum flashing of combined evaporator bottoms, gas recovery, and the stabilization of combined gasoline. Complementing the combination unit are gasoline treating and kerosine treating units, a complete power plant and auxiliaries.

Unique to refinery construction are the plant's sulphuric acid and drum manufacturing facilities. The sulphuric acid plant will reclaim spent acid as well as produce fresh acid for kerosine and water treating. The drum manufacturing operations will produce and fill about 15,000 five-gallon drums per day.

The refinery was constructed by the Kellogg International Corporation in under two years. Since it was necessary to employ local work forces, Kellogg established trade schools and trained Iraqis in the specialized crafts required for refinery construction including steam fitting, welding, ironworking, and electrical trades.

Chemical Society Symposium

The Chemical Society will hold a symposium on 'Recent Advances in the Chemistry of Colouring Matters' at the Royal Institution, Albemarle Street, London W1, on 2 February. The symposium will comprise an afternoon and an evening session. Advance proofs of the papers to be presented can be obtained by fellows, price 5s, from the secretary of the society.

CLASSIFIED ADVERTISEMENTS

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive, or a woman aged 18-59 inclusive, unless he or she, or the employment, is excepted from the provisions of the Notifications of Vacancies Order, 1952.

A Vacancy exists for a
WORKS CHEMIST
to be responsible for quality control with a Chemical Company associated with the oil industry.
Candidates should possess an A.R.I.C.A. Degree in Chemistry or Chemical Engineering, or hold equivalent qualifications.
Experience in a similar position will be an advantage, but is not essential.
Candidates should be between 22-30 years of age.
Salary, £800 to £1,500 per annum, according to age and experience.
Apply, giving full details, to:
BOX No. C.A. 3454,
THE CHEMICAL AGE,
154, FLEET STREET, LONDON, E.C.4.

BRITISH CAST IRON RESEARCH ASSOCIATION

THERE are several vacancies on the Research Staff of the British Cast Iron Research Association. These provide excellent opportunities for young men to carry out original and interesting work.

It is required in particular to fill the following posts immediately:

(1) Investigator for study of graphite formation and the solidification processes in cast irons and related alloys. This work will be of a fundamental character.
(2) Investigator for study of factors influencing the soundness of iron castings. This work is of profound practical importance but might involve fundamental consideration.
(3) Investigator for work on foundry moulding sands. This offers an opportunity for *research* work in a field of immense practical importance.

Applications are invited from young men qualified in metallurgy, physics or in chemistry, but consideration will also be given to applicants without special qualifications.

Superannuation, staff canteen, special transport facilities, agreeable surroundings.

Salaries will be commensurate with age, experience, and qualifications; applications (in writing) should contain these details and be addressed to British Cast Iron Research Association, Alvechurch, Birmingham.

DRAUGHTSMEN. Vacancies for Draughtsmen with experience in the following fields:—
(*a*) Heavy plant work
(*b*) Mechanical handling
(*c*) Structural steel
Working conditions and scope good. Five-day week, 3 weeks' holiday, luncheon facilities, pension scheme. Initial salaries depending on age and experience up to £800 per annum for senior men. Write, Staff Department, Huntington, Heberlein & Co., Ltd, 114, Cromwell Road, London, S.W.7.

CHEMIST required at **MINISTRY OF SUPPLY** Armament Research and Development Establishment near Sevenoaks, Kent, for physico-chemical methods of analysis including infra-red spectro-photometry. Qualifications: Higher School Certificate (Science) or equivalent but H.N.C., or pass degree in Chemistry an advantage. Some experience of electronics desirable. Salary within **EXPERIMENTAL OFFICER** range (min. age 26), £745-£920. Equal pay scheme. Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1., quoting F.964/5A/BZ. Closing date, February 4th, 1956.

GOLD COAST LOCAL CIVIL SERVICE
A Vacancy exists for a
GOVERNMENT CHEMIST,
Public Works Department, Gold Coast Local Civil Service (BCD112/13/018)

QUALIFICATIONS—
Honours Degree in Chemistry and Associateship or Fellowship of Royal Institute of Chemistry, preferably in Branch I. Sound knowledge of Bacteriology and Biology of Water Supply required. Experience of practical operation of water purification plant essential.

DUTIES—
Supervision of purification of Government water supplies and investigation of new supplies.

TERMS OF APPOINTMENT—
On contract terms for two tours of duty (18-24 months each tour) with consolidated salary according to experience in the scale £1,030-£2,020 per annum plus gratuity of £12 10s. for each completed month of resident service payable on satisfactory termination of contract. Outfit allowance between £50-£60 per annum, according to commencing salary. Free passages; quarters when available at rental of between £60-£90 per annum. Vacation leave at rate of 7 days for each completed month of resident service. Income tax at low local rates.

Apply, in writing, to
THE DIRECTOR OF RECRUITMENT,
COLONIAL OFFICE,
GREAT SMITH STREET, LONDON, S.W.1.,
giving briefly age, qualifications and experience. Mention the reference number BCD112/13/018 shown against the post applied for.

NORTHERN GAS BOARD
DARLINGTON DIVISION
Applications are invited for the position of
DIVISIONAL CHIEF CHEMIST

Candidates should be qualified to undertake full responsibility, under the Works Manager, for supervision of chemical staff, for all chemical testing, control of Glover West Vertical Retort Installation, modern C.W.G. Plants and ancilliary equipment. Corporate membership of the Institution of Gas Engineers or equivalent qualification will be an advantage.

The salary will be within Grade A.P.T.9 Provincial 'A,' (£700-£800 per annum) of the National Salary Scales, initial placing according to experience and qualifications. The successful candidate will be required to pass a medical examination and be subject to the Board's Pension Scheme.

Applications, stating age, experience, qualifications and the names of two persons to whom reference can be made, should be addressed to the undersigned not later than January 21st, 1956.

F. WILSON,
Divisional General Manager.
Gas Office,
John Street,
DARLINGTON.

HER MAJESTY'S OVERSEA CIVIL SERVICE
GEOCHEMIST IN THE GEOLOGICAL SURVEY DEPARTMENT, TANGANYIKA.

QUALIFICATIONS—A good Honours Degree in Chemistry or its equivalent. Some experience in Inorganic Analysis essential with special reference to rock and mineral analysis. Preference will be given to a candidate with post-graduate experience.

AGE LIMITS—Not over 40 years.

DUTIES—Analysis of rocks, minerals and ores; supervision of junior staff in routine analytical research; opportunities exist for research.

TERMS OF APPOINTMENT—On pensionable or contract gratuity terms with emoluments in the scale £852 to £1,620 per annum. 10 per cent cost-of-living allowance. Outfit allowance £45. Furnished quarters provided at a rental. Free passages. Generous leave; income tax at local rates.

Apply, in writing, to
THE DIRECTOR OF RECRUITMENT,
COLONIAL OFFICE,
GREAT SMITH STREET, LONDON, S.W.1.
giving briefly age, qualifications and experience. Mention the reference number BCD105/8/09.

IMPERIAL CHEMICAL INDUSTRIES LIMITED
METALS DIVISION
CHEMIST

THERE is a vacancy for a **CHEMIST,** University Graduate or equivalent, in our Ceramics Factory at Stourport-on-Severn, Worcs. Experience in this type of work, although not essential, would be advantageous. This post offers great scope for advancement to the right man.

Excellent conditions of employment include Pension Fund, Profit Sharing Scheme, etc. Financial assistance towards removal expenses is available for married men. Out of pocket expenses are paid to applicants invited for interview.

Application forms may be obtained from the Staff Manager, I.C.I. Metals Division, Kynoch Works, Witton, Birmingham 6, quoting ST/2.

SENIOR SCIENTIFIC OFFICERS
SCIENTIFIC OFFICERS

THE Civil Service Commissioners invite applications for pensionable appointments. Applications may be accepted up to December 31st, 1956 (June 30th, 1956, for posts in any branch of Chemistry or Biology), but early application is advised as an earlier closing date may be announced. Interview Boards will sit at frequent intervals. The Scientific posts cover a wide range of scientific research and development in most of the major fields of fundamental and applied science. In biological subjects the number of vacancies is small; individual vacancies exist for candidates who have special knowledge of, or who are interested in, Palaeobotany, Malacology, Helminthology, Acarology, Foraminifera.

Candidates must have obtained a University Degree, with first or second-class honours, in an appropriate scientific subject (including Engineering) or in Mathematics, or an equivalent qualification; or possess high professional attainments. Candidates for Senior Scientific Officer posts must in addition have had at least three years' post-graduate or other approved experience.

Candidates taking their degrees in 1956 may apply before the result of their degree examination is known.

AGE LIMITS—Senior Scientific Officers, between 26 and 31, but specially suitable candidates under 26 may be admitted; for Scientific Officers between 21 and 28 during 1956 (up to 31 for permanent members of the Experimental Officer class). Salary (London)—Senior Scientific Officers: (men) £1,070-£1,245; (women) £951-£1,155. Scientific Officers: (men) £513-£925; (women) £513-£850. Women's scales being improved under equal pay scheme. Somewhat lower rates in the provinces.

Further particulars from Civil Service Commission, Scientific Branch, 30, Old Burlington Street, London, W.1, quoting No. S.53/56 for Senior Scientific Officers and S.52/56 for Scientific Officers.
8734/120/EP/a/12/55.

LABORATORY ASSISTANT, finished National Service, of Inter. B.Sc. standard, required for interesting work in control laboratory. Good prospects, pension scheme, canteen. Apply, in writing, with details of age, experience and salary required, to **CHIEF CHEMIST, A. IBBETSON & CO., LTD., STEVENAGE, HERTS.**

MINISTRY OF SUPPLY require **CHEMISTS** or **CHEMICAL ENGINEERS** at Explosive Research and Development Establishment, Waltham Abbey, Essex, for following posts: (*a*) Formulation and processing of colloidal propellants involving liaison with production and Services. Knowledge of Thermodynamics would be useful. (*b*) Control of a pilot plant manufacturing propellants. Some experience of explosives an advantage. Appointment as **SCIENTIFIC OFFICER** (min. age 21) or **SENIOR SCIENTIFIC OFFICER** (min. age 26) according to age and experience, but at least 3 years' post-graduate research experience required for senior grade. Qualifications: 1st or 2nd class Honours Degree or equivalent qualification in Chemistry or Chemical Engineering. Salaries within range: S.O., £513 10s.-£925; S.S.O., £1,070-£1,245 (superannuable). Equal pay scheme. Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting F.951/5A/BZ. Closing date, February 4th, 1956.

NORTH WESTERN GAS BOARD
LIVERPOOL GROUP
ASSISTANT CHEMIST—LINACRE WORKS

APPLICATIONS are invited for the above pensionable appointment at a salary within Grade A.P.T.6 (£565-£645 per annum) with the opportunity for further advancement.

Applicants should be aged 25-30, possess a Higher National Certificate in Chemistry and have had industrial experience.

Apply, by letter, to
THE CHIEF PERSONNEL OFFICER,
N.W.G.B., LIVERPOOL GROUP,
RADIANT HOUSE,
BOLD STREET, LIVERPOOL,
within 14 days.

SENIOR DEVELOPMENT AND DESIGN ENGINEERS

SENIOR appointments are offered to qualified Engineers with experience on chemical plant. Applicants should be capable of directing and controlling the activities of a Development or Design Team and should hold a minimum qualification of 2nd-class Honours Degree.

THE APPOINTMENTS ARE WITH AN INTERNATIONALLY KNOWN COMPANY AND OFFER EXCELLENT CONDITIONS AND PROSPECTS OF ADVANCEMENT WITH A COMMENCING SALARY OF UP TO £1,750.

Applications, giving full details of qualifications and experience, to **BOX NO. C.A. 3452 THE CHEMICAL AGE, 154, FLEET STREET, LONDON, E.C.4.**

Situations Vacant—*continued*

UNITED COKE AND CHEMICALS COMPANY LTD producers of organic chemicals from coal, require a **TECHNICAL ASSISTANT TO THE COMMERCIAL MANAGER**. His duties will include market research, advertising, and technical liaison with research and works departments. He should have practical experience of sales or development or market survey work involving visits to outside firms on his own. Age preferred 27/35. Honours degree in chemistry desirable. Salary according to qualifications and experience. Pension Scheme.—Reply, giving personal details and brief account of education, qualifications, and experience, to the Commercial Manager, 34, Collegiate Crescent, Sheffield 10.

FOR SALE

MORTON, SON AND WARD, LIMITED,
offer
BROADBENT HYDRO EXTRACTORS

8 New 36 in. diam. galvanised baskets, electrically driven through centrifugal clutch. Safety interlocks.
6 New 36 in. diam., same as above but belt driven.
10 New 21 in. diam. galvanised baskets, electrically driven through centrifugal clutch. Safety interlocks.
8 New 21 in. diam., same as above but belt driven.

ALL THE ABOVE ARE STILL PACKED IN MAKER'S ORIGINAL CASES AND ARE ON OFFER AT UNREPEATABLE PRICES.

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New "**MORWARD**" "**U**"-shaped Vessels made to requirements in stainless steel or mild steel. Jacketed or unjacketed, with or without mixing gear.
50/100g. Heavy Duty **MIXERS** by **FALLOWS** and **BATES,** agitators driven through bevel gears from fast & loose pulley.

JACKETED PANS

NEW 100g., 150g. and 200g. in mild steel for 100 lb. w.p., with or without mixing gear.

SECOND-HAND PANS, MIXERS, etc., available from stock—all in good condition.

PUMPS

A selection of new **MONO** and other second-hand **PUMPS** in stock, 2 in. to 5 in.

MORTON, SON AND WARD, LIMITED,
WALK MILL,
DOBCROSS, NEAR OLDHAM,
LANCS.
Phone Saddleworth 437.

PHONE 98 STAINES

UNUSED ELECTRIC STIRRING ARMS—440/3/50, ½ h.p., 350 r.p.m.
Unused **CONDENSERS**—3 ft. 6 in. by 5 in. diam. 325 ½ in. copper tubes, 1,000 gal. **ALUMINIUM VEHICLE TANK.**
STAINLESS STEEL JACKETED MIXERS—39 in. by 32 in. 40 in. by 24 in. & 40 in. by 25 in. deep.
"Johnson" **CAST-IRON FILTER PRESS**—25 chambers, 24 in. sq. Ditto by "Dehne"—11 chambers.
12 **EDWARDS VACUUM PUMPS**—2 c.f.p.m., ¼ h.p., 230V.
TANKS, PANS, MIXERS, PUMPS, AUTOCLAVES, OVENS, HYDROS, STEAM & DIESEL PLANT, etc.

HARRY H. GARDAM & CO., LTD.,
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FOR SALE urgently, 100 tons Hot-pressed Naphthalene. Melting point 78 deg. H. M. Kershaw, Oxenhope, Keighley, Yorks.

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OVEN by Laboratory Thermal Equipment, No. 7251, thermostatically controlled at 105°C. with a max. of 250°C. Fitted two shelves 18 in. by 19½ in. with racks available for five shelves; loading 2,250 watts; suitable for operation on 100/110/1/50 cycles, but at present operating in conjunction with 20.5 amps, 230/110/1/50 cycles, transformer by G.B. Electrical Services Ltd.
ELECTRICALLY HEATED STILL by Manesty, capacity 6/8 pints per hour, suitable for 230/1/50 cycles.
GAS HEATED STILL by Manesty, capacity 6/8 pints per hour.
ROUGH BALANCE in glass case, capacity 250 grms. Complete with weights.
CHEMICAL BALANCE by Stanton, No. 6805, with set of first class analytical weights.
LABORATORY BALANCE by Towers, Capacity 210 grms. On beam 2 kilos on pan.
FUME CUPBOARD in three sections, two outer sections being 32 in. by 30 in., centre section 71 in. by 30 in., fitted with gas and electric connections, ducting and Exhaust Fan. Cupboards lined with sindanyo top and back. Exhaust Fan has capacity of 1,200 c.f.m. and is direct coupled to ¼ h.p. electric motor, 400/440/3/50 cycles, 1,400 r.p.m.
LABORATORY EXHAUST FAN, size 30 in., for 400/440/3/50 cycles.
TWO—LABORATORY HOT PLATES by G.E.C., 24 in. by 18 in. 2.5. kW. suitable for use on 220/230/1/50 cycles.
LABORATORY PESTLE & MORTAR MILL by Pascall, No. 5036, with steel mortar 9½ in. diam. by 4½ in. deep with steel pestle. Drive by fast and loose pulley from 1½ h.p. geared motor unit by NECO, 400/440/3/50 cycles running at 88 r.p.m.
FILTRATION BENCH, lined sindanyo 7 ft. by 2 ft. by 3 ft. high with filtration section 10 in. high to accommodate 24 filter funnels.

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Tel: Shepherds Bush 2070 and
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Tel.: Pudsey 2241.

1 S.J. WERNER MIXER—with pan approximately 2 ft. by 2 ft., of the tilting type.
2—**S.J. CAST-IRON FILTER PRESSES**—each with 38 s.j. plates and 39 frames, cake size 2 ft. 4 in. square.
Several Johnson **CAST-IRON FILTER PRESSES**—various sizes and types.
GARDNER MIXERS and Mixers and Sifters combined.
2 Cox **SINGLE-ROLL EDGE RUNNER MILLS**—belt driven.
HYDRO EXTRACTORS—24 in., 30 in. and 36 in.
2—18 in. **KEK PLATE MILLS**—with feeders, delivery bins, motors and entablature.
2—No. 4 **SUPER MIRACLE MILLS**—with motors and starters.
1—No. 2 **STANDARD MIRACLE MILL**—with 30 h.p. motor.
1—No. 1 ditto.
2 Single Effect **EVAPORATORS** by Scott—with pumps and motors.
3 Copper-lined **S.J. PANS**—60 lb. pressure.

RICHARD SIZER, LIMITED,
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Tel: HULL CENTRAL 31748.

ONE OVAL-SHAPED DISINFECTOR by Manlove & Alliott. Inside measurements, 30 in. by 50 in. high by 7 ft. long, steam jacketed, with hinged door each end. 30 lb. p.s.i. pressure. £80. **THOMPSON & SON (MILLWALL) LTD., LONDON, E.14 (TEL. EAST 1844).**

50 TONS Wool Wax. Accept low price for the whole consignment. Sample and analysis free. H. M. Kershaw, Oxenhope, Keighley, Yorks.

CHARCOAL, ANIMAL AND VEGETABLE horticultural, burning, filtering, disinfecting, medicinal, insulating; also lumps ground and granulated; established 1830; contractors to H.M. Government.—THOS. HILL-JONES, LTD., "INVICTA" WORKS, BOW COMMON LANE, LONDON, E. TELEGRAMS: "HILL-JONES, BOCHURCH LONDON." TELEPHONE: 3285 EAST.

WANTED

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